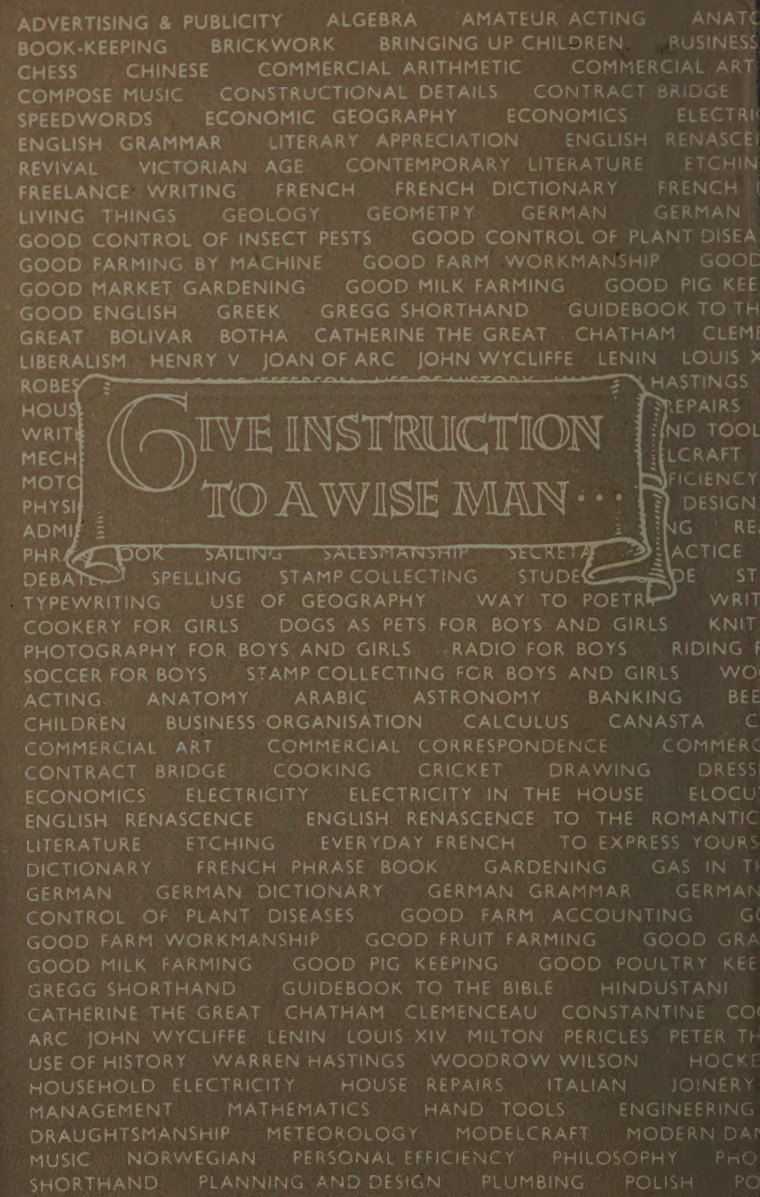
GIVE INSTRUCTION TO A WISE MAN · · ·

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JOINERY

By
T. O. HOWARD

THE ENGLISH UNIVERSITIES PRESS LTD
102 NEWGATE STREET
LONDON, E.C.1

First Printed 1951
This Impression 1959

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PRINTED AND BOUND IN ENGLAND
FOR THE ENGLISH UNIVERSITIES PRESS LTD
BY HAZELL WATSON AND VINEY LTD, AYLESBURY

GENERAL EDITOR'S FOREWORD

THE AIM of the Teach Yourself Building Series is to assist those who are desirous of acquiring information concerning building methods and practice.

It is not intended that these books will take the place of textbooks or recognised courses of study at Technical Colleges, but they should appeal to all students of building because each volume has been written by a specialist in his own particular subject.

The series covers almost every branch of the building crafts and allied professional practice.

In placing before the public this comprehensive work on Building, no apology is necessary for continuing to describe and illustrate traditional methods of building construction, because it is of vital importance that the layman who desires to become acquainted with building technique should be instructed in the basic principles of building.

There is really very little difference between traditional methods of building and the form of construction which has been developed to meet the requirements of the immediate post-war era. As pre-fabrication and standardisation will be the main features in the construction of post-war buildings, these materials and methods have been described and illustrated within the framework of this series, but no attempt is made to theorise on their comparative values.

The text has been written in a clear, concise, and interesting manner, and the constructional details throughout the series are portrayed by clear line diagram drawings.

Carpentry is that part of the craft which deals with the carcassing and construction of a building, whilst Joinery deals with the furnishings and fitments of a building. It is felt that the separation of the two sections will help to clarify many points which often appear difficult to a student of the craft of Carpentry and Joinery.

FOREWORD

THIS BOOK is intended to be a guide for those who are interested in joinery. It is also hoped that it will be of some use to the young apprentice who wishes one day to become a craftsman.

Most people have at some time attempted a little job about the house which entails the use of wood and woodworking tools. Usually a little guidance along the right lines would save a great deal of unnecessary labour and annoyance, as would also some knowledge of the correct tools to use, together with their care, maintenance, and manipulation.

These are three important factors which lead to the success of the finished article, for, as the saying goes, "It is a poor workman who blames his tools," and there should be no occasion for the good craftsman to do so.

There is a certain fascination about working with wood, and a great deal of satisfaction to be experienced when an article of joinery has been successfully finished.

It takes a long time and much practice to become a good craftsman, also a knowledge is required of many other matters than the use of tools. For instance, certain woods have qualities all their own, and something should be known about wood generally before choosing and working with it.

All these matters cover a very wide field, and although it is said that a little knowledge is dangerous, it is felt that some of the main points are essential for the beginner, therefore an effort is made in this book to explain in simple text all that is considered necessary to encourage good craftsmanship.

Joinery is distinct from carpentry, and may be classed as the art of designing, constructing, and fixing all the various wood fittings to be met with in and around buildings.

Most of this work is first made at the bench in a workshop, where all the necessary tools and appliances are available.

Carpentry, on the other hand, deals with all work of a constructional nature, such as roofs, floors, partitions, etc., and although this type of work is often important, the same neatness is not usually required as in joinery, where great care and accuracy should always be the aim.

All work is dealt with purely as handwork, wood-working machinery being outside the scope of this book.

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CHAPTER I

TOOLS

To advise the beginner on the choice of a kit of tools is very difficult, because there are so many tools required for different jobs and such a variety of jobs. A set of tools as shown in Plate I would cover most types of work, but all of these tools may be too many for a beginner.

However, quite a lot of work can be executed with the minimum number of carefully chosen tools, which should be of the best quality and made by reputable firms. Cheap tools are of very little use, and it is false economy to buy two or three cheap tools for the price of one good one.

Plate I shows a collection of such tools which are considered necessary, and it is suggested that these tools are purchased first, others may be added as time goes on and the need is felt for extras.

Woodworking tools by themselves will not turn out first-class work; it is the craftsman who must manipulate them in the correct manner to do this; therefore a sound knowledge of how to use them and, just as important, how to sharpen, adjust, and maintain them is very necessary.

The following explanation of the use of tools will include some of the extras in order that a general knowledge may be gained before starting to work in wood.

Setting-out Tools (Plate II)

The most indispensable of these are the rule and pencil. The 3-foot or 2-foot fourfold boxwood rules (Fig. 1) are the most used, but which of the two is the better is a matter of personal opinion. The 2-foot rule may be used to advantage in confined spaces. Any ordinary HB pencil is sufficient for marking planed wood, but on rough-sawn wood the carpenter's pencil is much better. This has a

PLATE 1.—SPECIMEN SET OF TOOLS.

rectangular-section lead which makes a thick line, lasts longer, and is less liable to break.

The Marking Awl (Fig. 2) is used to prick off points in accurate work, and the marking or striking knife (Fig. 3) for cutting lines across the grain. The cut thus formed leaves a much cleaner finish than when sawing to a pencil line only. These two tools may be combined in one, but as shown they are easier to handle and safer, because the wooden handle is uppermost in each case.

The Try Square (Fig. 4) is a most essential part of the joiner's kit, as it is in constant use for the testing and marking of all right angles. It is composed of a hardwood stock, into which is riveted a thin steel blade, fixed to form an angle of 90°; and the edge of the stock is lined with brass to prevent wear. Squares may be obtained in the following sizes: 3, 6, 9, and 12 in., the length from the tip of the blade to the edge of the stock being the size in each case.

The Combination Square (Fig. 5) has a metal stock through which slides a 12-in. steel rule. This may be locked in any suitable position on the blade and used to mark off angles of 90° and 45°. It can also be used as a pencil gauge when marking lines parallel to the edge of a piece of wood.

The Sliding Bevel (Fig. 6) is used to mark off or test any angle other than a right angle; the slotted blade being moved to the desired angle and locked by means of a set-screw.

Wing Compasses (Fig. 7) are composed of two finely pointed steel legs 6 or 8 in. long which are set to the desired position and held by a setscrew and quadrant. They are used when stepping off a number of equal spaces, marking circles or arcs, and when scribing parallel lines to straight or curved work.

Marking Gauge (Fig. 8).—Gauges are used to mark lines parallel to the edge of a piece of wood. The stock is set to the desired distance from the steel point and fixed by the thumbscrew. It is then held firmly against the edge of the

PLATE II SETTING OUT TOOLS

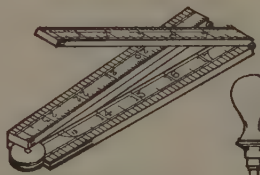


FIG 1 2 FT FOURFOLD RULE

FIG 2 MARKING AWL

FIG 3 MARKING KNIFE

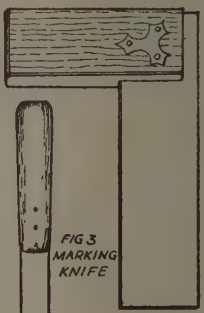


FIG 4 TRY SQUARE

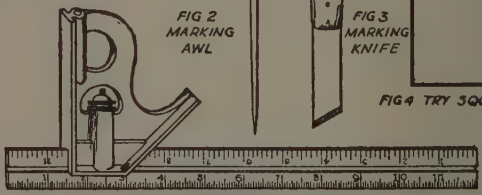


FIG 5 COMBINATION SQUARE

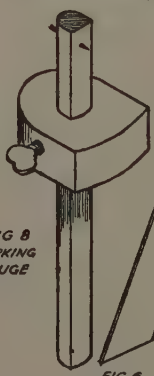


FIG 8 MARKING GAUGE

FIG 6 SLIDING BEVEL

FIG 7 WING COMPASSES

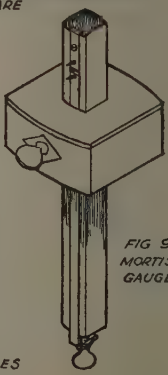


FIG 9 MORTISE GAUGE

wood and pushed along, the sharp steel point marking the line.

Mortise Gauges (Fig. 9).—These are similar to marking gauges, but have two points for gauging double lines. One point is fixed near the end in the stem and the other in a sliding brass strip which is adjustable as indicated by the thumbscrew at the end.

Saws (Plate III)

Wood is composed of fibres which run mostly in one direction, and some thought should be given to the action of saw teeth when cutting these fibres. When cutting across the grain a different action is required from the saw teeth than when ripping with the grain, therefore different types of saws are used, as one type cannot do both jobs successfully.

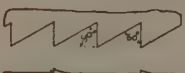
The Ripping Saw (Fig. 1) is used for cutting with the grain. It is 28 in. long, and has large teeth, usually 3½ or 4 points to the inch. The front or leading edge of the tooth forms a right angle with a line joining the points, and should be filed square across the saw, with no bevel on front or back of the tooth. The action of these teeth is that of a series of chisels, which tear out shavings each equal to the width of a tooth. The large space between the teeth, known as the gullet, is essential in a rip-saw in order that these minute shavings will not choke up the saw before being finally ejected from the saw cut.

The Cross-cut Handsaw (Fig. 2) is 26 in. long, and, as the name implies, is used for cutting across the fibres. The action of the teeth is that of a series of knives which sever the fibres and force out the waste wood in the form of sawdust. The resistance is greater when cutting across the fibres, therefore the cross-cut saw has more teeth, 6½ or 7 to the inch. These teeth have a good bevel on the front edge and are inclined to the line of cut to enable them to cut easily through the fibres.

Panel Saws (Fig. 4) are similar to the cross-cut, but smaller

PLATE III. SAWS

FIG 1 RIP SAW



RIP SAW TEETH

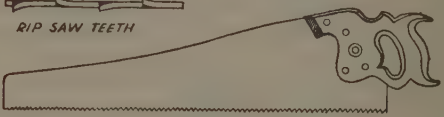
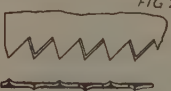


FIG 2 CROSS CUT HANDSAW



CROSS CUT & PANEL TEETH

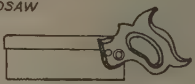


FIG 3 DOVETAIL SAW

FIG 4 PANEL SAW

PEG TEETH FOR DOVETAIL & TENON SAWS

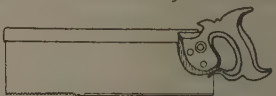


FIG 5 TENON OR BACK SAW

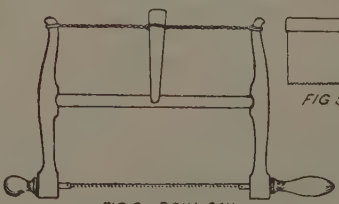


FIG 6 BOW SAW

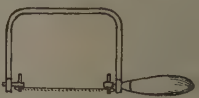


FIG 7 COPING SAW

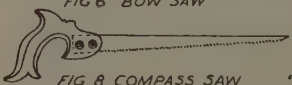


FIG 8 COMPASS SAW

FIG 9 PAD SAW

and lighter, and have the teeth spaced from 8 to 10 to the inch. These saws are used for fine work, mostly on the bench, and as they are often used for ripping as well as cross-cutting, the teeth have slightly more hook than those of a cross-cut saw.

Tenon or Back Saw (Fig. 5).—This saw is mostly used for cross-cutting when a finer and more accurate finish is required. The blade, being very thin, is stiffened by means of a doubled strip of iron or brass, which is pressed tightly along the top edge of the saw. Care should be taken to see that this strip is not damaged or bent by careless handling, or the result of such damage will be a twisted blade, which will prove very difficult to put right. The tenon-saw blade is 3½ in. wide and 12–14 in. long, with teeth spaced about 12 points to the inch. The teeth are shaped in the form of an equilateral triangle, and are sometimes termed " Peg " teeth.

Dovetail Saw (Fig. 3).—This is a smaller type of back saw, with a blade 7–10 in. long and teeth spaced 14 or 16 to the inch. It is used for fine cutting, such as dovetails in small work.

Compass Saw (Fig. 8) has a narrow tapering blade riveted to an open-type wooden handle. The teeth are spaced 12 to the inch and similar in shape to those of a rip-saw. These saws are used for cutting curves, and may be obtained as a set of three separate blades of varying sizes which are fixed into a special handle by means of setscrews. These are known as interchangeable saws.

Pad or Keyhole Saw (Fig. 9) is the joiner's smallest saw, the blade being about 10 in. long, and tapered from ⅜ in. to ¼ in. in width. The handle or pad is slotted in its length to receive the blade, which may be withdrawn to the desired length and secured by setscrews. This saw is useful for cutting keyholes, or the starting of any interior cuts, by inserting the blade in a small hole bored for that purpose.

Bow Saws (Fig. 6).—The long narrow blade is holed at each end to clip on to pins in the handles, and is held in tension

by twisting the string with the small wooden lever. These saws are used for cutting quick curves, and, as the handles revolve in their sockets, the blade can be adjusted to any desired position when in use. Blades vary in width from $\frac{1}{8}$ in. to $\frac{1}{2}$ in., and the length is in proportion. The frames are usually of beech, and may be home-made.

Coping Saws (Fig. 7) are a small cheap type of metal bow saw. The blade is held in tension by the spring-steel frame and may be rotated as in a bow saw. They are useful for small, light, circular cutting similar to fretwork. As the blades are so slender, the saw must not be pushed when cutting, as this would tend to buckle the blade. The reverse action must be used, that is, drawn towards the user with the teeth pointing towards the handle.

Planes (Plate IV)

The planes in general use are the jack, trying, and smoothing planes, and are known as the bench planes. When planing up a rough piece of wood, the jack plane is the first one used. It takes off the rough surface, and any irregularities left by the saw, thereby leaving a reasonably smooth surface for straightening with the trying plane and later finishing off with the smoothing plane.

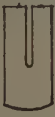
The Jack Plane (Fig. 1) has a beechwood body, handle, and wedge, and is 17 in. long, 3 in. wide, and 3 in. deep. It has two irons, one known as the cutting iron and the other as the back iron. These are held together by a small setscrew, and kept in position on the bed of the plane by the wedge. The angle of the bed to the sole of the plane is 45° (see Fig. 4).

The Trying Plane (Fig. 2) is the largest of the bench planes, and is similar to the jack plane excepting for the handle, which is known as the closed type. The length of the plane varies from 22 in. to 26 in. and the section of the body is $3\frac{1}{2}$ in. by $3\frac{1}{2}$ in., with irons $2\frac{1}{2}$ in. wide. This plane is used when truing up lengths of wood and for shooting straight the edges of boards, prior to gluing up a joint. It will be readily understood that the longer the plane, the less chance

PLATE IV PLANES

SHAPE OF CUTTING IRON FOR SMOOTHING AND TRYING PLANES

FIG 2 TRYING PLANE



SHAPE OF JACK PLANE IRON

FIG 1 JACK PLANE

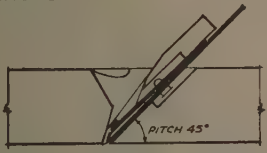


FIG 4 SECTION THROUGH A JACK PLANE

FIG 3 SMOOTHING PLANE

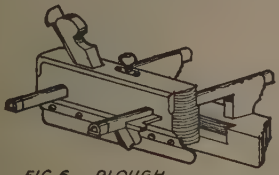


FIG 6 PLOUGH

FIG 5 REBATE PLANE

FIG 8 SPOKESHAVE

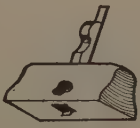


FIG 7 ROUTER

there is of forming hollows in the surface of the wood, such as would occur if a very small plane were used.

The Smoothing Plane (Fig. 3) has a beechwood body 8 in. long and 3 in. deep, with curved sides. It has double irons 2–2¼ in. wide, and is used for finishing off surfaces after they have been trued up.

The Rebate Plane (Fig. 5) has a single iron which is set at an angle across the sole, with its cutting edge operating the full width of the plane. It is used for forming sinkings on the edge of material, known as rebates, as its form allows it to work right into the angle. May be obtained with the iron square across the sole, but the skew iron works better. Widths range from ½ in. to 2 in. wide.

The Plough Plane (Fig. 6).—This is a very useful plane for forming grooves parallel with the grain, and a full set of irons, nine in number, vary in width from ⅛ in. to ⅝ in. The irons are of the single type held in position by a wedge, and care should be taken to see that the V groove in the back of the iron seats properly on the V edge of the thin metal guide plate. The depth of groove is controlled by a depth gauge which is fixed on the body of the plane and operated by a thumbscrew. The distance of the groove from the edge of the material is obtained by sliding the body along the two arms to the required distance from the fence, and then securing them by the attachment on the plane. Some ploughs have wedges for this purpose and others have the arms threaded, with wooden nuts both sides of the body. This is the better type, as the nuts allow an easier adjustment.

Router or Old Woman's Tooth (Fig. 7).—Used for cleaning out and levelling the bottom of grooves or trenches to a constant depth, after the bulk of the waste material has been taken out with saw and chisel; may be used either with or across the grain. Usually the body and wedge are home-made and plough irons are used as the cutters.

The Spokeshave (Fig. 8).—This is a form of small plane used for cleaning up quick curves. The metal type has a cutter

similar to a short plane iron, and adjustment is by means of screws. The cutter of the wooden type has two tapered prongs which fit tightly into holes in the stock, and is adjusted by tapping in or out. These cutters are hollow ground on the back, and should be sharpened on the bevelled side only and never rubbed on the back. If the hollow is lost through constant rubbing on the oilstone, the working of the spokeshave would be greatly impaired.

Chisels (Plate V)

The Paring Chisel (Fig. 1) is used for shaping and preparing the surfaces of wood and is manipulated by the hands, the handle being so shaped to give better control than the usual round types. The blade may be bevel-edged or flat, and the length ranges from 9 in. to 21 in. The chisels may be obtained in widths from $\frac{1}{4}$ in. to 2 in., rising by $\frac{1}{8}$ in. to 1 in., and then by $\frac{1}{4}$ in. up to 2 in.

Bevel-edged Chisels (Fig. 2) are very useful when cleaning out trenches and grooves or when dovetailing, as the thin edges allow of better access into corners and angles.

The Firmer Chisel (Fig. 3) has a flat blade about 5 in. long which is stouter than that of a pairing chisel, as it is required to withstand the blows of a mallet. Used for all forms of chisel work, including light mortising. The width of blade advances by $\frac{1}{16}$ in. up to $\frac{1}{2}$ in. and thereafter by $\frac{1}{8}$ and $\frac{1}{4}$ in. to 2 in.

The Mortise Chisel (Fig. 6) is used solely for mortising, and has a longer and stouter blade than the other chisels. The blade is much thicker towards the neck, and is finished off in the form of a socket, into which is fitted the wooden handle, instead of the usual tang which fits into the handle in the case of other chisels. These chisels are so made in order to withstand the heavier mallet blows, and also a certain amount of leverage when clearing the waste in a mortise. Blades vary in width from $\frac{1}{8}$ in. to $\frac{3}{4}$ in.

Gouges (Figs. 4 and 5).—These tools are a form of circular-faced chisel, with a range of sizes similar to that of paring

PLATE V. CHISELS

FIG 1
PARING
CHISEL

FIG 2
BEVELLED EDGE
CHISEL

FIG 3
FIRMER
CHISEL

FIG 4
SCRIBING
GOUGE

FIG 5
FIRMER
GOUGE

FIG 6
MORTISE
CHISEL

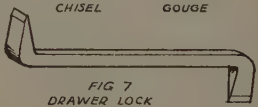


FIG 7
DRAWER LOCK
CHISEL

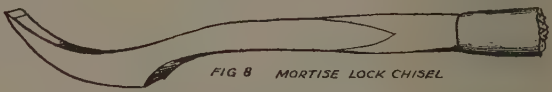


FIG 8 MORTISE LOCK CHISEL

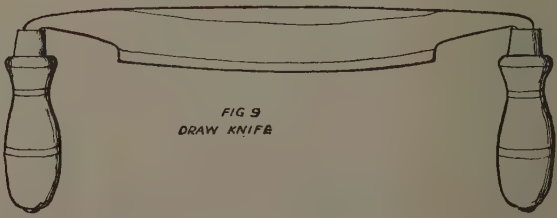


FIG 9
DRAW KNIFE

chisels, and may be had with very flat or quick curves. When ground and sharpened on the inside face (Fig. 4), they are known as scribing or paring gouges, whilst those sharpened on the outside are called firmer gouges. Long-bladed flat gouges, inside ground, are useful for paring off waste wood, as the corners do not dig in.

The Drawer-lock Chisel (Fig. 7).—A small steel tool with the ends sharpened as chisels. Useful for cutting sinkings or mortises in confined spaces, such as the opening for a drawer, when mortising for the bolt of the lock.

The Swan's Neck or Mortise-lock Chisel (Fig. 8) is used for cutting across the grain or cleaning out a deep mortise, such as that in the end of the rail of a door when fitting a mortise lock. It is so shaped to enable a levering action to be used and to cut across the end grain of a mortise where the straight chisel would be useless.

The Draw Knife (Fig. 9) is a two-handed knife bevelled and sharpened on one edge. It takes the place of the chisel on broad surfaces, being much wider, and is used for roughly reducing timber to a line before finally cleaning off with plane or spokeshave. May be used for wide chamfers.

Hammers and Screwdrivers (Plate VI)

The Warrington Hammer (Fig. 2) is the type mostly used for bench work and all light jobs. It is sometimes called the "Cross-pein hammer," the flat portion of the head being the pein. The head is cast steel, the face and pein being tempered; the shaft, which is wedged tightly into the head, is made of ash or hickory. The size and weight of these hammers are indicated by a number, and for most light jobs a No. 2, weighing 12 oz., or a No. 4 at 16 oz., would be suitable.

The Claw Hammer (Fig. 1) is better for heavy work, as it may be used for driving or withdrawing large nails. There are many different brands of hammer on the market, and

when making a choice, care should be taken to see that the hammer is the correct weight and well balanced in the hand.

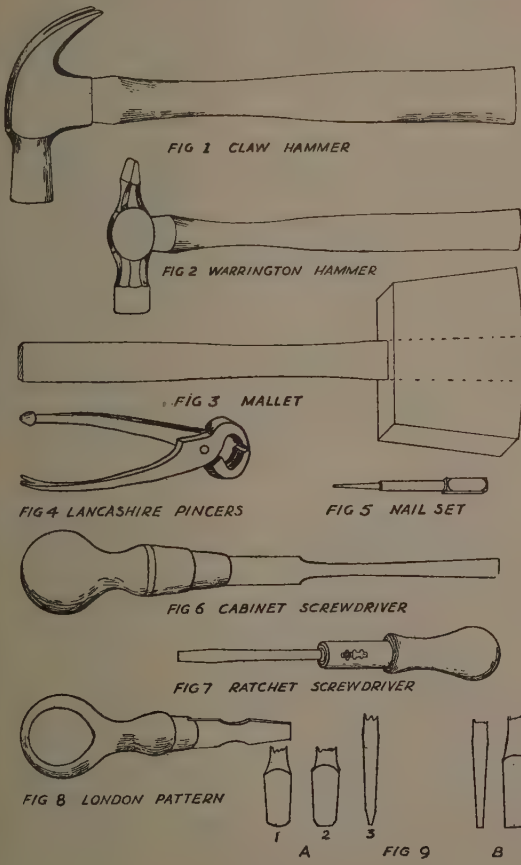
The Mallet (Fig. 3) is a "wooden-headed hammer" usually made of beech or ash. The hole for the shaft is tapered, being larger on the wide side of the head. The tendency is for the head to tighten on the shaft when in use and thus prevent it flying off. A mallet should always be used on chisels and gouges, as the constant use of a hammer will soon cause the handles to split.

Pincers (Fig. 4).—The pincers shown are termed "Lancashire," owing to their particular shape. There are other types, each with its own shape and name, but all have a similar grip and lever action when pulling out nails, tacks, etc.

Nail Set or Punch (Fig. 5).—Made from short lengths of high-grade special tool steel, with both ends hardened. The tapered end finishes in a small blunt point, which is cupped to prevent slipping when nail heads are being driven below the surface of the wood. The end of the punch used should be slightly smaller than the nail head to prevent enlarging the hole. Sizes of tip $\frac{1}{32}$–$\frac{5}{32}$ in.

Screwdrivers.—These may be obtained in various shapes and sizes, but the one shown in Fig. 6 is considered to be the best type. It is known as a "Cabinet screwdriver," and has a shaped handle which is comfortable to use and at the same time gives sufficient leverage. A large screwdriver with a thin handle is not to be recommended, as it is the diameter of the handle which determines the amount of leverage obtained when turning a screw. Blades range in length from 3 in. to 12 in., and one about 8 in. long would be suitable for the usual run of jobs. A short, stumpy screwdriver (Fig. 8) is handy for work in confined spaces, so also is a small ratchet screwdriver (Fig. 7). By adjusting the small spring slide on the handle, a ratchet screwdriver may be used to tighten or slacken a screw, this adjustment being made by the thumb whilst the screwdriver is in use.

PLATE VI. HAMMERS & SCREWDRIVERS



A ratchet screwdriver can also be used as a fixed-blade type. It is important that the end of the blade should be a good fit in the groove of the screwhead, being the correct width and thickness. If allowed to become worn or shaped as shown at *A*, Fig. 9, the screwdriver will invariably slip out of the groove and damage the screwhead. The end of the blade should be straight and the sides almost parallel, as shown at *B*, Fig. 9.

Oilstones.—These may be obtained in grades known as coarse, medium, or fine, and the best-known varieties of stones are Carborundum, Washita, Turkey, and India. A medium-grade stone is recommended, size 8 in. by 2 in. by 1 in., and a good-quality thin oil should be used on the stone. A mixture of neat's-foot oil and paraffin for this purpose is quite good. A hardwood box with a lid should be made to house the stone; this will protect it from breakage and keep it clean.

Slipstone is a small oilstone shaped to facilitate the sharpening of curved tools, such as gouges, spokeshave irons, axes, etc.

Boring Tools (Plate VII)

The Brace (Fig. 1) is used for holding and turning a bit for boring holes, the bit being gripped by the spring jaws in the chuck, which are tightened by screwing up the outer cover. The best type of brace has a ratchet incorporated with the chuck; and the head, handle, and ratchet revolve on ball bearings. With the ratchet brace a hole may be bored when the brace cannot be turned through a complete circle, as the ratchet enables the brace and bit to be turned in one direction and the brace only in the opposite direction.

The Bradawl (Fig. 2) and the Gimlet (Fig. 3) are hand-propelled tools, and are used to bore small holes for the insertion of nails, screws, etc. Gimlets should be used with care when boring near the end of a piece of wood, because the shape of the end tends to cause a splitting action.

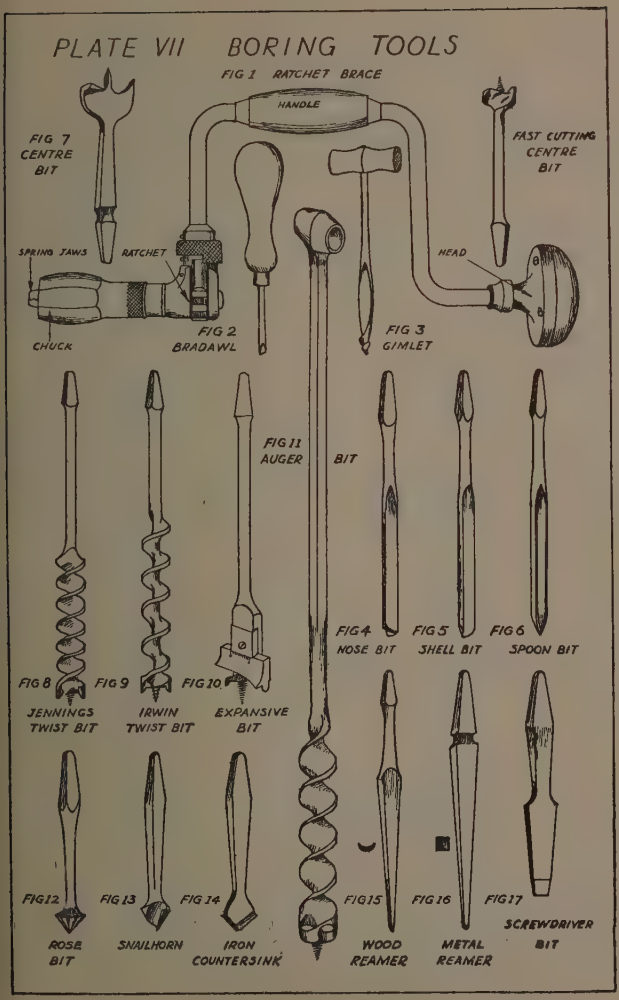


PLATE VII BORING TOOLS
FIG 1 RATCHET BRACE
HANDLE
FIG 7 CENTRE BIT
FAST CUTTING CENTRE BIT
SPRING JAWS
RATCHET
HEAD
CHUCK
FIG 2 BRADAWL
FIG 3 GIMLET
FIG 11 AUGER BIT
FIG 4 NOSE BIT
FIG 5 SHELL BIT
FIG 6 SPOON BIT
FIG 8 JENNINGS TWIST BIT
FIG 9 IRWIN TWIST BIT
FIG 10 EXPANSIVE BIT
FIG 12 ROSE BIT
FIG 13 SNAILHORN
FIG 14 IRON COUNTERSINK
FIG 15 WOOD REAMER
FIG 16 METAL REAMER
FIG 17 SCREWDRIVER BIT

Brace Bits

Nose Bits (Fig. 4), Shell Bits (Fig. 5), and Spoon Bits (Fig. 6).—These are useful tools for boring small holes up to $\frac{1}{2}$ in. diameter. The nose bit is the most suitable for boring with the grain. The spoon bit has a sharpened point, and is slightly quicker in action than a shell bit. The *nose bit*, with its small cutter at the end, will withdraw the core easier than the shell bit and spoon bit. These bits require continual pressure to force them into the wood, as they are not self-feeding, and they should be frequently withdrawn to remove the core. They are fairly quick in action and are easily sharpened.

The Centre Bit (Fig. 7) is used for forming shallow holes across the grain. When a hole is to be bored through a piece of wood, it is necessary to bore from both sides to prevent bursting out the fibres on the back side, as would occur with this type of bit. Centre bits produce an accurate and clean hole and may vary from $\frac{1}{8}$ in. to $1\frac{1}{2}$ in. in diameter.

The Auger or Twist Bit has a screw point and a helical or twisted stem. Two well-known types are the *Jennings pattern* (Fig. 8) and the *Irwin* (Fig. 9). These bits produce a clean accurate hole either with or across the grain, but pressure is required when boring with the grain, because the screw point does not easily feed into the wood. These bits may be obtained in sizes from $\frac{1}{4}$ in. to $1\frac{1}{2}$ in. diameter, rising in $\frac{1}{16}$ in., and short lengths in certain sizes are known as Dowel bits.

Expansive Bits (Fig. 10).—The main cutter on these bits can be adjusted to varying diameters within a certain range. It is fixed to the desired mark on the scale, and clamped in position by the plate and screw shown in the diagram (Fig. 10). Extra cutters of varying diameters are supplied to cover a range of diameters from $\frac{1}{2}$ in. to $1\frac{1}{2}$ in. The term "*Auger*" is applied more to twist bits with a long plain steel stem which has an eyelet at the end. A round hard-wood handle is fitted into the eye, and the bit is rotated by

hand. These are used for deep holes of a diameter up to 2 in. Fig. 11 shows an Auger bit with a type of nose suitable for boring into end grain.

Countersink Bits are used for recessing the heads of screws into wood or metal. The Snailhorn bit (Fig. 13) is for use in wood and the Rose bit (Fig. 12) for use in brass or hardwoods, whilst the iron countersink (Fig. 14), as its name implies, is for use in iron.

Reamers are used for enlarging holes when the standard size is not quite correct. The wood reamer (Fig. 15) is like a shell bit tapered from about $\frac{1}{2}$ in. to a point, and should be sharp along both edges. An iron reamer (Fig. 16) is square in section and tapers to a point; it is suitable for most metals.

The Screwdriver Bit (Fig. 17) is used in a brace to obtain greater leverage than the screwdriver when turning large screws.

CHAPTER II

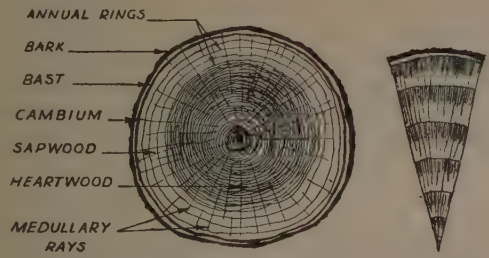
TIMBER (Plate VIII)

Growth and Structure

THE term timber is applied to the trees which provide us with wood. These trees are known as outward growers, due to the fact that each year a new layer of tissue is formed on the outside of previous layers. The layers are termed annual rings, because most trees produce one ring each year. Each annual ring is composed of an open porous layer known as springwood, due to the rapid growth in spring, and a thinner denser layer called autumn wood, due to the slowing down of the growth in late summer and autumn. In spring the outer rings of the tree known as sapwood convey the watery sap from the roots up to the leaves. This sap, containing mineral salts in solution, helps to feed the buds and leaves. Here it undergoes certain chemical changes, and on its return journey to the roots in autumn, this perfected sap leaves behind various starchy secretions, gums, or resins according to the type of tree. These substances fill up the tissues, feed the tree, and help to form a denser wood known as Duramen or heartwood. The cambium layer situated between the sapwood and the bark is responsible for the formation of new wood each year. It divides up, forming a layer of new wood cells on the inside and a soft layer on the outside, which becomes bark. Each year the innermost layer of sapwood becomes transformed into heartwood.

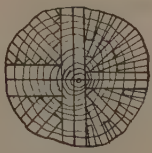
It is generally understood that heartwood is the only part of the tree which should be converted for use, as sapwood is more prone to attack from wood-destroying organisms. If sapwood is properly treated with an effective preservative, it is as durable as heartwood, similarly treated, when used under conditions favourable to decay. Where strength is the main consideration and the timber is not exposed to

PLATE VIII. TIMBER



CROSS SECTION OF A LOG AND PORTION OF A 6 YEAR OLD TREE

SLASH CUT



QUARTERED LOG
RADIAL OR RIFT SAWN

SHRINKAGE AND WARPAGE IN BOARDS WHEN SLASH CUT

CIRCUMFERENTIAL SHRINKAGE

ALTERATION OF SHAPE DUE TO SHRINKAGE

conditions of decay, there is little to be gained by differentiating between sapwood and heartwood. The difference in colour between sapwood and heartwood is most important when choosing wood for joinery, the decorative value of which depends on the dark colour and grain of the heartwood. Treating with preservatives is useless and staining is very difficult, as sapwood absorbs stain more readily than heartwood and takes on a much darker shade. Therefore, for all joinery work it is better that sapwood be eliminated altogether.

Seasoning

The advantages of seasoning are, that it makes the timber lighter in weight, more resilient, and less liable to twist, warp, and split. It is also in a better condition to retain its size and shape after being made into a piece of joinery.

Seasoning of timber is the process whereby the surplus moisture is drawn from the green timber by evaporation, thus allowing the natural juices to harden. The trees are felled when reaching maturity and the logs roughly squared into balks. The best method is to stack the balks under cover, so that a free circulation of air is provided all round them.

This method, known as natural seasoning, is slow, but gives the best results. A further period of seasoning should take place after the balks are sawn up and converted into planks or boards. This is to help dry out the interior of the timber which has been exposed by sawing.

As the moisture evaporates during seasoning, shrinkage of the timber takes place, so that if a balk is dried too quickly on the outside, splits and cracks will appear. Shrinkage in the length is negligible, but is more pronounced in the direction of the annual rings (see Plate VIII).

Sapwood shrinks more than heartwood, so that a board cut from the outside of a log will shrink more, and have a greater tendency to warp, than one cut from the centre.

Artificial Seasoning.—By this method the period of seasoning is very much reduced, a matter of two or three weeks being sufficient according to the size or species of timber to be seasoned. The timber is stacked on a special truck and wheeled into a chamber which is then sealed. Hot air is circulated by fans, and a certain amount of steam is added in order to retain the correct humidity. Samples are tested at intervals to ascertain the percentage of moisture remaining in the timber. Seasoned timber still contains a proportion of moisture, which varies from 16 to 22 per cent. according to the atmospheric conditions, and this need not be dried out any further if intended for use out-of-doors.

If used for interior work or in a heated atmosphere, the timber should be further conditioned, that is, dried in warm-air kilns, or stored in a similar atmosphere to that in which it will be fixed, until the moisture content is brought down to the region of 8–12 per cent.

Moisture content is the amount of water in a sample, expressed as a percentage of the dry weight of the wood sample itself.

Timber which has been stored in a damp atmosphere should not be converted into a piece of joinery and then fitted into a warm room. The result will be rapid shrinkage, warping, twisting, and splitting.

Timber Identification

To be able to identify any timber is a job for the expert, as a great deal of confusion is caused by the number of different names given to one kind of timber and the number of timbers which are so much alike. However, an effort will be made to describe the woods most commonly used in joinery.

Commercial timbers are divided into two classes, softwoods and hardwoods. The softwoods are those of the coniferous or cone-bearing trees such as pines, firs, spruces, etc., those trees with long narrow leaves or evergreen needles. The main characteristics of these woods are

straight fibre, soft regular grain mostly resinous, pale or slightly tinted in colour. The annual rings are very distinct, there being a marked contrast between spring wood and autumn wood, and the medullary rays are not visible. Hardwoods belong to the broad-leaved trees, and, although the texture varies, they are generally denser and harder than the softwoods. The wood is non-resinous, highly coloured, and often figured; the annual rings are not so distinct, but the medullary rays are visible in most, and in some cases are very pronounced. There is a much wider range of variation in the texture of hardwoods than softwoods, and although some broad-leaved woods are soft, and some coniferous woods are quite hard, this does not affect their classification botanically.

Softwoods

Redwood—European (*Pinus sylvestris*).—Known as Scots pine, northern pine, or red pine, and when imported from Baltic ports, as "fir," "red," or "yellow deals." Is a native of Scotland and all northern countries of Europe. The colour of the heartwood varies, from yellowish brown to reddish brown, the annual rings being very distinct; the autumn wood dense and resinous; the spring wood softer and pale yellow. The sapwood is narrow, pale creamy white, liable to discoloration known as "blueing," and has very little resistance to decay. European redwood is easy to work with all tools, and nails, screws, and glues well, and although an excellent constructional timber, may be used for most types of joinery.

Red Pine (*Pinus resinosa*), known also as Canadian, Ottawa, or Quebec red pine, and often confused with Baltic redwood, which it very closely resembles. Red pine is paler in colour, has more sapwood, and is slightly softer and lighter in weight. As it compares so favourably with redwood, it can be used for the same purposes: doors, windows, cabinet work, etc., and exterior joinery. It can be painted and

stained quite easily, and when used externally should be treated with a preservative.

Yellow Pine (*Pinus strobus*).—Is a native of Canada, where it is called Eastern white pine, and, in North America, soft pine. The wood is a pale straw colour, and the annual rings are not so distinct as in other pines. It is slightly resinous, and the resin ducts appear as small brownish flecks on the surface of a board. It is the softest and lightest of the pines and seasons well; very little shrinkage, warping, or twisting takes place. Yellow pine is one of the most easily worked timbers, and takes glue, stain, paint, and polish well; is not liable to split when being nailed or screwed. This wood is excellent for pattern-making, high-grade joinery, as a core or base for veneering, or any work which is required to keep its shape and not twist, shrink, or warp.

Pitch Pine (*Pinus palustris*).—This is the hardest, heaviest, and strongest of the pines, and is used mostly for constructional purposes. The wood is very resinous, and the heartwood varies in colour from light red to dark orange; the annual rings are narrow and clearly marked by the dense hard summer wood, the sapwood is very narrow and greyish white. Owing to the abundance of resin, the wood is difficult to work, and tools must be kept oiled to prevent them sticking. Care is needed in seasoning, as pitch pine has a tendency to checking and splitting, and, as shrinking goes on for some time after seasoning, this wood is not suitable for high-class joinery. The uneven shrinkage of spring and summer wood prevents the retention of a good surface, and the resin which is exuded acts as a solvent on paints and varnishes.

Firs and Spruces

Douglas Fir (*Pseudotsuga taxifolia*), also known as British Columbia pine or Oregon pine, due to the fact that the tree grows mostly in these states. Present supplies are from British Columbia, and the best quality is graded as prime

clear, the rest as select merchantable or merchantable. The wood is rather like the milder types of pitch pine, but without the same resinous character; it is straight-grained although coarser in texture, and long lengths are obtainable free from knots. When slash cut, i.e. sawn tangential with the annual rings, a pronounced figure is obtained, due to the marked difference in density between spring and summer wood. Much of this timber is now used for veneers and plywood. Douglas fir seasons well without much checking, is fairly easy to work, and is better stained and varnished than painted, as the grain has a tendency to lift. Used for all constructional purposes, joinery, cabinet work, and interior fittings, masts, and flagpoles.

European Whitewood (*Picea Abies*).—Other names, white deal, white fir, Norway spruce, and, in Scotland, white pine. The wood is whitish yellow, the annual rings distinct, and there is very little difference between the heartwood and sapwood. It works well with most tools, and finishes smoothly with a satiny lustre. The chief defects of this timber are the numerous small hard knots and its limited sizes. Although it has a tendency to split and warp, and shrinks and swells easily, it is useful for kitchen fittings, shelves, food containers, etc., owing to its clean white surface and lack of odour.

Russian Spruce (*Picea exelsa*), or Archangel whitewood, is about the best for spruces. It has less defects, is lighter, sounder, and easier to work, and although it has very hard loose knots, they are small and not so numerous.

Canadian Spruces.—These are divided into three groups: Quebec spruce, New Brunswick spruce, and Nova Scotia spruce, according to the port of shipment. The bulk of imported Canadian spruce is called white spruce (*Picea glauca*), and there is little difference between these spruces and the European species. If anything, they are slightly less tough or strong than Norway spruce, less resinous, and in appearance more of a dull white than the lustrous yellow

of the European type. Selected grades are used for organ pipes, oars, masts, and ladders.

Sitka Spruce (*Picea sitchensis*).—Other names are often given to this species, such as: silver spruce, western spruce, tideland spruce, Menzies spruce. The heartwood is pale brown in colour, merging into a creamy-white sapwood, and when planed the surface has a distinct silky sheen. It is straight-grained, tough, and elastic, and owing to its lightness and strength is used extensively for aircraft work. Like other spruces, it is useful for food containers, joinery work, and sounding boards for musical instruments.

Western Red Cedar (*Thuja plicata*).—Comes from British Columbia and western U.S.A., and is one of the largest conifers native to North America. The sapwood is small and light yellow in colour, merging into the heartwood, which has a large variety of colours, from pink to dark brown. These colours will change to a silvery grey if the wood is left exposed to the weather. It is clean and straight-grained, but very soft, with a tendency to pick up when being planed. The timber seasons well, does not shrink very much, and will afterwards withstand weather variations with very little movement. It is practically immune to all forms of decay, including dry rot, and attack by insects. It is useful for weather-boards, roof shingles, and all forms of garden carpentry, and its lightness and steadiness make it an excellent timber for cores of flush doors. Galvanised iron or copper nails should be used, as cedar will corrode iron and become stained.

Hardwoods

Canary Whitewood (*Liriodendron tulipifera*).—Other names are American whitewood, Tulip tree, Green cypress. Grown in eastern North America, and, though classed as a hardwood, is soft, even-textured, straight-grained, and easy to work. The colour varies, from a greenish yellow to darkish brown, often with purple streaks. Care is required

in conversion and seasoning as there is a tendency to warping, but with proper attention to these matters, this timber should give little trouble. It is suitable for interior joinery, furniture, and turnery, or as a core for veneers; takes paint, stain, and polish well, and is often stained and polished to imitate mahogany, ebony, or walnut.

Ash (English and European) (*Fraxinus excelsior.*).—English ash is considered the best for the purposes for which it is employed. The wood is tough and flexible, and, when steamed, bends easily, thus making it useful for vehicle body-work, aircraft construction, and sports and agricultural implements. It is also used for panelling, furniture tool handles, and boatbuilding. In young trees there is an abundance of sapwood which is silvery white varying to yellowish brown in the heartwood of old trees; there is a marked contrast between spring and summer wood, which gives a good figure. Its texture sometimes makes it difficult to plane, but it can be glued and stained and polishes well. The European ash is not as tough or as strong as English, and is milder in texture.

White Ash (*Fraxinus Americana*) and Black Ash (*Fraxinus nigra*) are the two main varieties of American ash, and are very much alike except for the darker shade of brown in the Black ash. The grain of American ash is much straighter and slightly coarser than English, and, though not quite such good quality, the wood is used for the same purposes as English.

Beech (*agus sylvatica*), is a native of Britain, Central and Southern Europe. The wood is usually straight-grained, has a fine texture, and there is very little difference between the sapwood and heartwood. It is hard and fairly heavy, the colour varying from white or pale brown to a reddish brown; the medullary rays are distinct in cross section, but when beech is radial cut, the figure is not very distinct, as the markings are small and of a similar colour to the remainder of the wood. Beech is one of the strongest of British timbers, but is not particularly durable, except

when kept continuously dry or wet. The wood works easily with most tools, and takes stain and polish well; when steamed, it bends easily, and is used for bentwood furniture and vehicle body-work. It is a good turnery wood, and is used for a variety of kitchen utensils, chair legs, reels, bobbins, tool handles, etc. Beech does not absorb water or warp readily, and it is for this reason that it is used for the stocks of planes; it also makes excellent floorings.

Spanish Mahogany (*Swietenia mahagoni*).—Also known as Cuban, or San Domingo, and is the best of the mahoganies, being strong, close-grained, with a fine texture, and often beautifully figured. The timber seasons well and does not shrink, swell, or warp readily; the colour of the wood is a rich brownish red which darkens with age. It works well with all tools, is a good turnery timber, and takes a high polish; is used mostly for car furniture, high-class joinery, ships' fitments, and yacht construction. Owing to the small sizes of the logs and the limited supplies, Spanish mahogany is now being replaced by African and Honduras, of which greater supplies and larger sizes are available.

Honduras Mahogany (*Swietenia macrophylla*).—This name covers a large variety of the Central American mahoganies from such places as Mexico, Peru, and Brazil, that from Honduras Bay often being termed Baywood. The colour of the wood varies from a pale yellowish or light red to dark reddish brown similar to Cuban; this is due to the varying conditions under which it is grown. It has many of the properties of Cuban, but is lighter in weight and softer, being straight-grained, easy to work, does not " give " much, glues, stains, and polishes well. Used for all types of high-class joinery, pattern-making, veneers, and panelling, and, as it is durable, is used extensively for the planking of yachts, racing craft, and speed-boats.

African Mahogany (*Khaya ivorensis*).—Although not considered a true mahogany, African is more widely used than Cuban or Honduras, being cheaper and easier to obtain,

though not of the same high quality. The wood is of a coarser texture, fairly easy to work, but can be troublesome, due to twisted or interlocking fibres which cause portions of the surface to pick up or tear when being planed. Although it has a tendency to warp and twist, it is a very useful timber for general interior joinery, furniture, counter-tops, fittings, and veneers.

Sapele (*Sapele mahogany, scented mahogany*).—A West African timber which is becoming popular in this country, having a similarity to African mahogany, although harder and heavier. It is close-textured, with a distinctly striped grain sometimes mottled; pinkish-coloured, heartwood darkening to a mahogany brown after cutting. Seasons fairly well, but splits and warps unless quarter sawn. Works fairly well with hand or machine tools, but the grain is liable to pick up when planing. Used largely for veneers for furniture, cabinet work, panelling, and shop fittings.

Maple Rock (*Acer saccharum*).—Hard maple, Sugar maple (sapwood), Canadian maple. Figured forms known as Birds'-eye or Fiddle-back. Eastern Canada and eastern states of U.S.A. Main commercial species. Not much difference between sap- and heartwood, but heartwood sometimes has reddish tinge. Colour creamy white. Hard dense wood, stands up well to abrasion (flooring). Works well to a fine finished surface, and takes high polish.

Flooring of all types, furniture, sports goods, bowling alleys, dairy appliances, coach-work, piano actions, turnery, joinery, panelling.

Oak (*Quercus genus*).—Oak is grown freely in Europe, America, and Asia, and is often known by the name of the place from which it is shipped, or by the method of its conversion for use. It is considered one of the strongest, toughest, and most durable commercial timbers, but varies in quality according to the locality in which it is grown. The general characteristics of oak are: heartwood, yellowish brown; sapwood, lighter shade; the annual rings are distinct, and are composed of a layer of dense

tissue and an open or porous layer. A large number of medullary rays are easily seen radiating from the centre, and when oak is cut parallel to these, the beautiful figure known as silver grain is produced. The heartwood is very durable, both for interior and exterior work, but the sapwood is liable to attack from wood-boring insects. The European varieties secrete an acid which will corrode iron and stain the tissues of the wood in the process.

English Oak is considered the strongest and most durable of the oaks, but care is needed when seasoning, as it is liable to twist, warp, and split. It is hard and often difficult to work, but has a beautiful figured grain.

Austrian and Polish Oaks are milder and easier to work than English, and are less liable to warp when being seasoned.

There are many varieties of American Oak, the most important being White Oak (*Quercus alba*), which is grown over a very large area and varies considerably in texture. Generally speaking, the American oak is softer and straighter grained than European, it seasons quite well, is fairly easy to work, does not split easily, and does not corrode iron. The heartwood varies in colour from yellowish brown to a reddish brown, and the sapwood is nearly white. When radial cut, the figure does not compare with the English oak, being rather dull and lifeless.

Japanese Oak (*Quercus grosserrata*).—Rather like English in colour, but the silver grain is not so pronounced, and tends to run in horizontal stripes across the boards. It is lighter in weight, softer, milder, and rather porous, straight-grained, even-textured, works easily, and planes up to a smooth finish. Used mostly for internal joinery, furniture, and carving. Oaks generally are used for a large variety of purposes, a few being: heavy constructional works, carriage framing, fencing, flooring, exterior and interior joinery, furniture, shipbuilding, and cooperage.

Teak (*Tectona grandis*).—This is the only true teak, and is grown in Burma, India, Siam, and Java, the bulk of supplies

coming from Burma. The colour of the wood is a light golden brown which darkens with age. The grain is straight, open, and porous, and free from knots. Teak does not face up well owing to its porous nature, and the gritty secretion in the pores soon dulls the edges of cutting tools. It seasons well, and is not liable to warp or shrink after seasoning. It is strong, durable, and resistant to acids, moisture, and insects, being used for heavy constructional purposes, outdoor work, kitchen and bathroom fittings, benches, fittings, and sinks in laboratories and chemical works, shipbuilding, and railway work.

Walnut (*Juglans nigra*).—Known as American or Black walnut, and is the largest and most important of the walnut species. The heartwood is a rich purplish brown when cut, but changes to a dull dark brown, almost black, as it dries. The sapwood is white and fairly narrow. The timber seasons well with little shrinkage, and rarely casts or warps when in use. It is hard, strong, and durable, is easily worked, faces up well, and is ideal for french polishing. On account of these properties the wood is used for gun and rifle stocks, other uses being high-class joinery and cabinet work, and veneers for panelling, etc.

Timber, Selection and Buying

Choosing timber is not an easy matter at the best of times, but during the war years and since, when timber has been in short supply, it has been a matter of taking what one can get, and not being able to select good-quality timber for a job.

Consequently, a large amount of inferior timber has been used on jobs where in normal times it would not be entertained. Home-grown timber has been used extensively, and no doubt the results of using unseasoned timber have long since become apparent in many cases. Young workers and beginners have been used to putting up with anything, and do not know what good-quality timber looks like. They do not realise that most home-grown timber is not

suitable for good joinery work, or that it is necessary to select the right kind of wood for a certain type of work.

In normal times, when timber is plentiful, it should be carefully selected for the job in hand, the quality or grade noted, and any defects taken into consideration. The notes on identification and the few notes on defects to follow should help the beginner to realise that one of the most important operations is the selection of the right kind of timber.

Timber is sorted and graded sometimes into three or four grades, the best being known as first-quality or prime, and the price varies accordingly.

When selecting, all sapwood should be avoided, also boards with waney edges. Waney edge is the term applied to boards with partially rounded edges which denote the outside surface of the log. These boards will surely contain sapwood, and will have to be reduced in width, therefore they are uneconomical.

Deadwood is timber which has gone beyond maturity or has lain for a long time on the ground before being sawn up. It is usually in the first stages of decay and will never be of any use, and, although it may appear to be quite sound, it can be recognised by the hard dead feeling of the wood when being sawn.

Knots may be either live or dead, and in cases where it is not detrimental to the appearance, a live or sound knot is quite permissible. If the timber is used for structural purposes, then large live knots detract very much from the strength and should be avoided.

Dead knots are often loose, or if only partially so, are easily detected, and timber so affected should not be purchased.

Shakes or cracks are often quite obvious, but sometimes very difficult to detect. They are present in the tree when it is growing, but do not always show until after the timber has been worked. Very often they open up when the timber is being seasoned, especially at the end of a board, as this

will dry out quicker than the remainder. Cupshakes follow the direction of the annual rings, and are often inside the piece of wood and seen only from the end. When exposed by sawing, cupshakes will cause a piece of wood to fall apart owing to the separation round the annual rings.

Heartshakes and starshakes follow the medullary rays and cause radial cleavage of the tree.

Druxiness is a form of decay started while the tree is growing and due to spores of fungus finding their way into the wood and causing decomposition. When timber is converted, druxiness is seen as pale spots or streaks which are very soft and lacking the texture of the rest of the wood. There are other forms of decay to look for, one being foxiness, which is common to certain hardwoods such as oak, and is indicated by reddish-brown streaks when in the early stages. Another form is doatiness, which is common to oak, beech, and birch, and may be seen as whitish streaks with a sprinkling of black specks or outlined with black.

Many other defects, including twisted grain, interlocking grain, upsets, and coarse grain, are developed when the tree is growing, and although not always detrimental, they can cause much trouble when an effort is being made to clean up or face the material. Good-quality timber should therefore be free from all these defects, and may be tested for soundness by striking a length on the end with a hammer, the result being a clear ringing sound.

When buying timber do not order the exact amount, but make due allowance for such as ends which are split or need squaring up, and take into consideration the fact that a 6-in. by 1-in. rough board when planed all round will only be about $5\frac{3}{4}$ in. by $\frac{7}{8}$ in.

When ordering tongued and grooved boards, an allowance of about 10 per cent. should be made for wastage in cutting and for the loss in effective width due to the tongues.

It is better to order in bulk, either in super feet or linear feet, with perhaps a preference for certain lengths. Try to keep to standard sizes and take the nearest length. Special

sizes or exact lengths mean extra time spent in selection, and this would only increase the cost.

The following terms and sizes are given to timber in its market form:

Log is the felled tree after being trimmed.
Balk is the log after squaring up.
Planks.—11–18 in. wide and 3–6 in. thick.
Deals.—Up to 9 in. wide and 2–4½ in. thick.
Batten.—Up to 7 in. wide and 1½–2 in. thick.
Board.—Less than 1½ in. thick and over 6 in. wide.
Quartering.—2 in. by 2 in. up to 6 in. by 6 in. square stuff.
Scantling.—Odd-cut stuff, such as 3 in. by 2 in., 4 in. by 2 in., 4 in. by 3 in.
Laths.—Up to 4½ in. wide and ½–1½ in. thick.

Plywood

Plywood is a manufactured or reconstructed wood which is made up of an odd number of thin *plies* or veneers that are glued together under pressure and formed into thin sheets of fairly large dimensions. The layers are so arranged that the grain of each one is at right angles to that of its neighbour, and the number of layers may be 3, 5, 7, or 9.

When the centre ply is thicker than the outer or face plies, the board is known as " Stoutheart," and with 5 or more veneers of equal thickness, the term " Multi-ply " is used. The thickness of plywood will be given in millimetres if foreign, such as 6 mm., which is just under ¼ in., or if English ⅛ in., ¼ in., etc.

In cheap plywoods the thickness is not constant.

The timbers commonly used are alder, birch, Douglas fir, and Gaboon mahogany, and sheets may be faced on one or both faces with figured oak, walnut, or mahogany. Plywood may also be faced with—or have as a core—metal, cork, or asbestos, and is used for insulating or fire-resisting purposes.

Other forms of plywood now becoming available are moulded strips, shaped and curved sheets.

Laminated or Lamin-boards.—These boards range in thickness from $\frac{3}{8}$ in. to 2 in., and are composed of a core built up from narrow strips not exceeding $\frac{3}{8}$ in. wide, which are glued together, the whole being faced on both sides with a thin ply.

Blockboard.—Very similar to lamin-board, except that the core is composed of wider strips, usually $\frac{3}{4}$ in. or $\frac{7}{8}$ in. The cores are cut from close-grained softwoods or Gaboon mahogany.

Plywoods and laminated boards may be used for a variety of purposes, chief among these being panelling, either on walls or ceilings, panels in solid framing, and flush doors.

Lamin-board may be used for fielded panels, being veneered to match the solid hardwood framing. Boards with very wide laminations in the core should not be used for veneering, as the strips will become very noticeable when veneered and polished; therefore, the laminated board is the best choice for veneering, as the very narrow strips used in the core will not be so pronounced.

Although plywood and laminated boards do not swell or shrink to any great extent, they will twist and warp. In the case of wall panelling, the backs of the sheets should be painted with some form of bitumastic paint, and adequate ventilation provided; where edges are exposed, they should be suitably treated to prevent moisture entering the core.

CHAPTER III

JOINTS

Halving Joints (Plate IX)

THE halving joint, also termed a half-lap joint, may be usefully employed in many types of framing where strength and appearance are of secondary consideration. The aim of this joint is to secure the corners and intersections of the framing, and at the same time keep all the faces flush, that is, in the same plane. The joints should be glued and screwed together. The dovetail halving (Fig. 3, Plate IX) is an improvement on the T-joint, and may be used to advantage in cases where there is a strain in one or both members which would tend to pull the joint apart. If properly made, the shoulder will pull up tightly when the joint is assembled, and screws or nails will only be required to keep the two pieces together in the direction in which there is the least strain.

When making this joint the piece *B* should be cut first and then marked out on the other piece, and in setting out the dovetail care should be taken to see that the slope is not too great and that a small setback is made at corner *A*, in order that the saw cut may be started easier than if the line went to the corner.

When setting out, the shoulder lines should be cut in with a marking knife and a small V-groove chiselled on the waste side (see Fig. 5, Plate IX). This enables the saw to start the cut tight against the line and prevent it from wandering. Gauging for the depth should be done from the face of each piece, so that if the line is not exactly in the centre, the faces will still come up flush when the joint is assembled. Sawing should be done on the waste side of the lines as shown.

Fig. 7, Plate IX, shows the waste being chiselled out from each side and taken down to the gauge line before removing the centre. On no account should the waste be chiselled straight through from one side, as there is danger of bursting

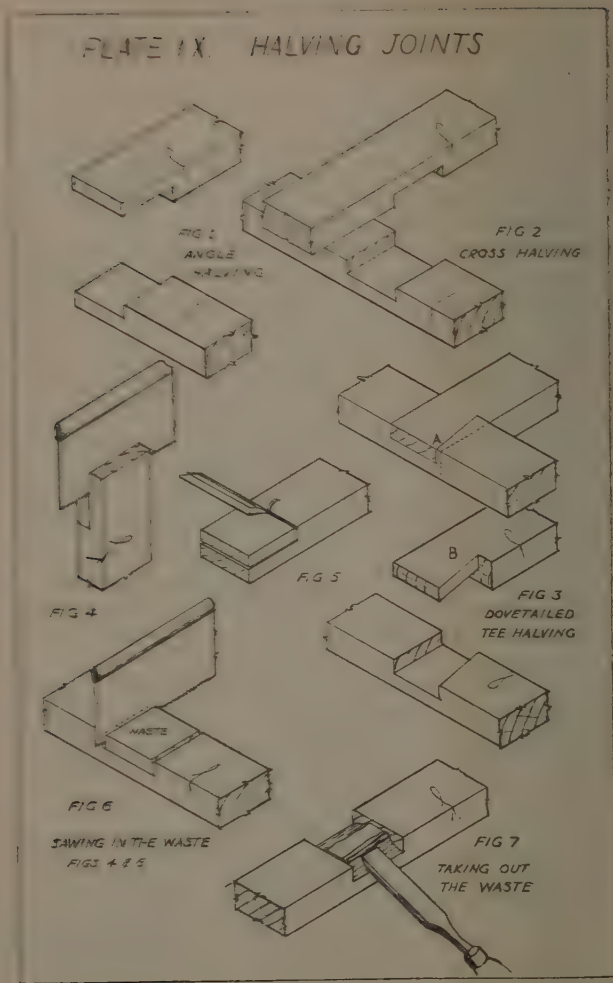


PLATE IX. HALVING JOINTS
FIG 1
ANGLE
HALVING
FIG 2
CROSS HALVING
FIG 4
FIG 5
B
FIG 3
DOVETAILED
TEE HALVING
WASTE
FIG 6
SAWING IN THE WASTE
FIGS 4 & 5
FIG 7
TAKING OUT
THE WASTE

FIG. 1.

through below the line, which cannot be used as a guide. Fig. 1 shows the remaining waste being levelled off to the gauge line: note the fingers controlling the chisel.

Mortise and Tenon Joints (Plate X)

In joinery, the mortise and tenon joint is one of the most important joints, and is used extensively in the various forms shown in Plate X. Although so much of this hand-work is now done by machines, there are many occasions when the joints must be made by hand, and to be able to turn out a good-fitting mortise and tenon joint quickly is a test of good craftsmanship.

Carelessness or lack of knowledge is the cause of many an ill-fitting and badly made joint which could so easily have been avoided.

First a word about the proportions of the joint, as this point must be considered when setting out the work.

For general framing work the width of a mortise is about one-third the thickness of the material to be mortised, and

the length should not exceed six times the width. This is done to ensure that the tenon will not be so wide as to be affected by shrinkage, or so thin that it will buckle when wedged up.

Fig. 1, Plate X, shows the plain mortise and tenon joint with the tenon left the full width of the rail, as in this case the width does not exceed six times the thickness of the tenon. When the joint is pinned, the pin should be kept near to the shoulder, for, as the pieces are held by the pin, any shrinkage of the stile will not be so severe on the shoulder side of the pin as on the outside, therefore the joint will be held reasonably tight.

Fig. 2 shows how allowance must be made in the length of the mortise for the grooves which reduce the width of the tenon.

The haunched tenon joint (Fig. 3) is used at the corner of a piece of framing where strength is required without weakening the stile. The tenon is reduced to half the width of the rail, leaving a small portion at the root called a haunch, which fits into the groove in the stile. The rail is thus held for its full width and prevented from warping, and sufficient wood is left at the top of the stile for wedging without bursting the wood. It is a mistaken idea to use wide tenons and small haunches, as the top of the stile is considerably weakened by so doing.

With a wide rail as in Fig. 4, half the width of the rail is used for tenons, this being again divided into two small tenons, the remaining portion in the centre being used as a haunch. This divided tenon is often wrongly termed double tenons, but the true double tenons are shown in Fig. 6, and are used when the timbers are very thick and a single tenon would not be sufficient.

The barefaced tenon (Fig. 5) occurs in a boarded door, where the boards pass over the face of the rail, which is thinner than the rest of the framing, and flush on one face only.

Fig. 7 shows how rebated framing affects the shoulders of

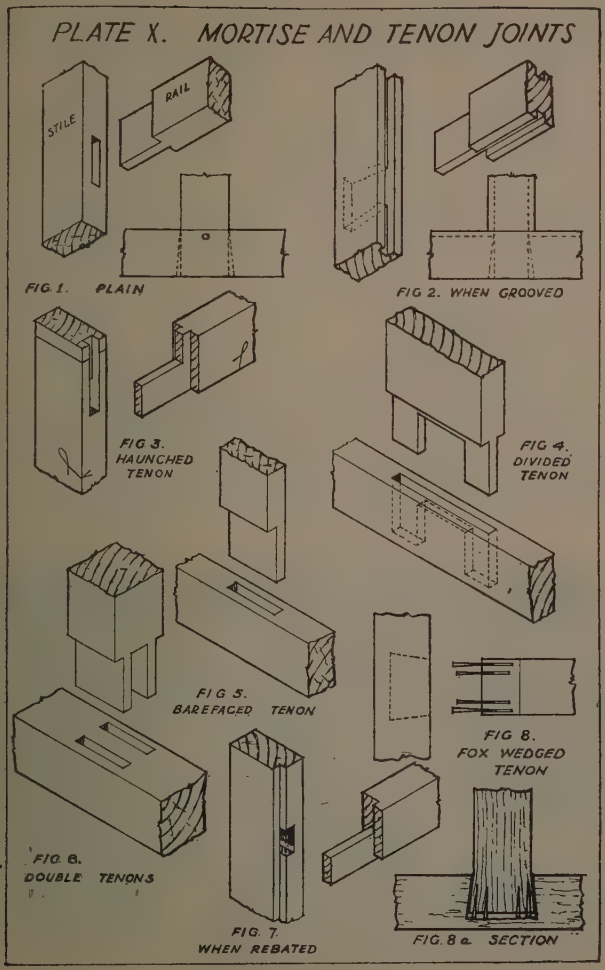


PLATE X. MORTISE AND TENON JOINTS
STILE
RAIL
FIG. 1. PLAIN
FIG 2. WHEN GROOVED
FIG 3. HAUNCHED TENON
FIG 4. DIVIDED TENON
FIG 5. BAREFACED TENON
FIG 8. FOX WEDGED TENON
FIG. 6. DOUBLE TENONS
FIG. 7. WHEN REBATED
FIG. 8a. SECTION

a rail and are known as long and short shoulders. The fox-wedged tenon joint may be employed in all cases where the edge of the framing is seen and it is not desirable to show the ends of the tenons and wedges. Great care should be exercised in making this joint, as the wedges must be just the right size and shape, so that when forced home they will open the saw cuts and cause the tenon to spread out and just fill the dovetail-shaped mortise.

Fig. 8*a* shows a section through the joint after it has been cramped up and the wedges forced into the cuts.

Making the Joint

Having decided on the width of the mortise, the nearest-sized mortise chisel is chosen, and the points of the mortise gauge are set to allow the chisel to just pass between the tips (see photograph, Fig. 2). The stock of the gauge is then set to position the mortise correctly, and all mortises and tenons are then gauged with the one setting, care being taken to see

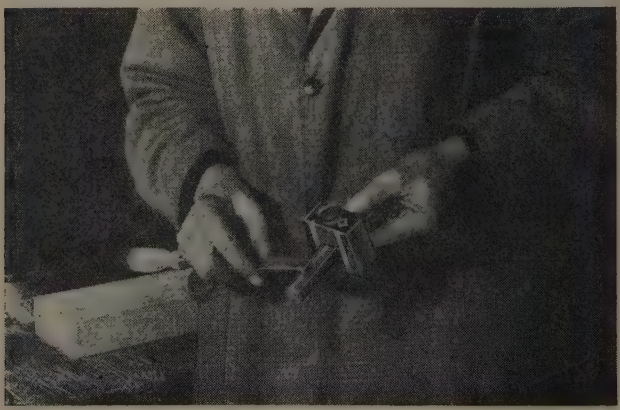


FIG. 2.

that the stock is held firmly against the face side of the timber (see photograph, Fig. 23). There are a number of methods of cutting a mortise, the following being one of the best :

Stand end on to the timber in order to sight the chisel and see that the mortise is being cut parallel to the sides of the stuff. Start with the chisel held vertically and the flat face about $\frac{1}{8}$ in. inside the line (see Fig. 3). With a sharp blow of the mallet drive the chisel into the timber about $\frac{1}{2}$ in., and then, without turning the chisel, take off an inclined slice of the waste. Repeat this until the chisel has been driven by easy stages to about half the depth of the timber, then cut out slices of the waste until the opposite end of the mortise is reached, turn the chisel round and repeat the original process. By now the mortise should be half-way through, and most of the waste removed. Turn the piece of wood over and repeat from the other side, clean out the waste and cut the wedge room—that is, gently slope the ends of the mortise about three-quarters of the way through to allow for the wedges (see Figs. 1 and 2, Plate X).

For large mortises, a brace and bit may be used to remove most of the waste, but this method is not to be recommended for small mortises, as great care and accuracy are required to keep the bit between the gauge lines. The direct chisel method, if properly carried out, will quickly produce a mortise of the correct dimensions, and there should be no need to trim the sides, as would be the case after using the boring method.

The method of sawing tenons and shoulders is similar to that already explained for halving joints (Figs. 4 and 6, Plate IX). The saw cuts should be in the waste, and just touching the gauge line, not right on it.

The correct saw for ripping down the tenons is the rip or half-rip saw (see photograph, Fig. 4), and, although the tenon or back saw is often used for ripping small tenons, its real use is fine cross-cutting, such as the shoulders (see photograph, Fig. 5).

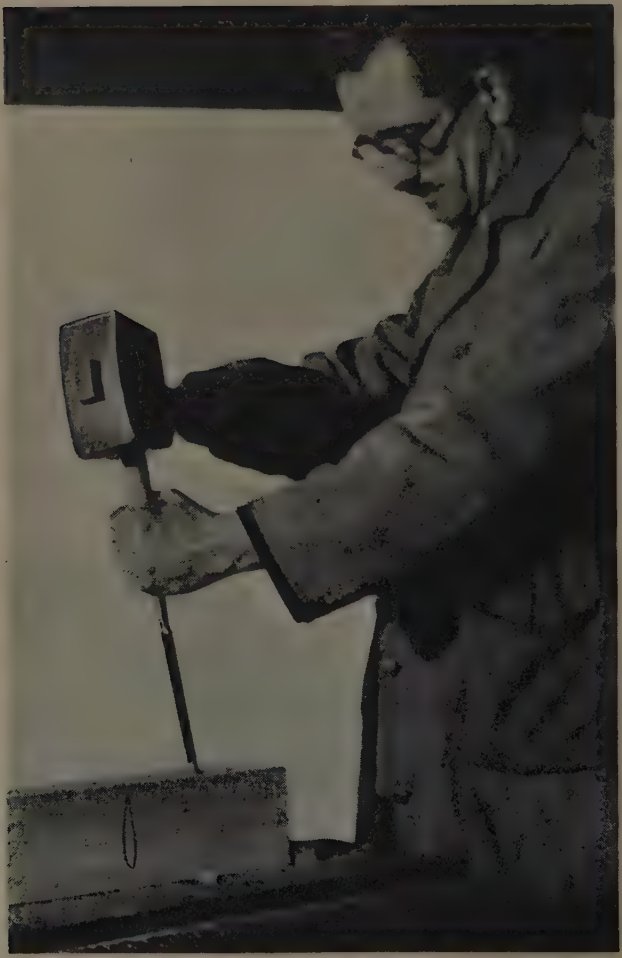


FIG. 3.

FIG. 4.

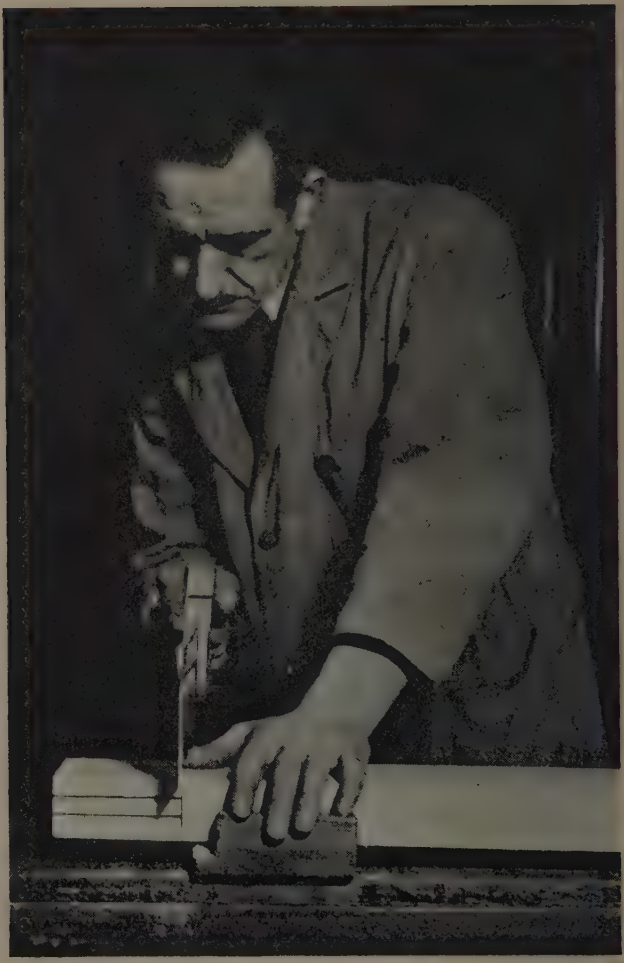


FIG. 5.

Dowelling (Plate XI)

The dowelled joint is often used as a framing joint in the place of the mortise and tenon joint, and although it is easier to make and effects a saving of time and material, it is not considered to be as good as the mortise and tenon joint. However, in spite of this, the dowelled joint may be used to advantage in many cases, such as the joints in circular work, butt jointing two edges where additional strength is required, or positioning movable fittings.

A typical dowel joint is shown in Fig. 1, Plate XI, while Fig. 2 shows some examples of setting out according to the size of the material used, the intersections of the lines forming the centres for dowel bit.

In Fig. 3, *A* is a section through a well-made joint, whereas *B* shows what happens when one hole is not bored perpendicular to the joint face. The section at *C* shows one set of holes bored out of centre or not opposite the others; this prevents the faces of the frame from coming up flush.

Setting out should be very carefully carried out, and an example of how this can be done for a small number of pieces is shown in Fig. 4. Note how the face-marks are arranged in order that the two stiles will be a pair when finished, and how the squaring and gauging are being done from the face in each case. When repetition work is required a templet such as the one shown in Fig. 5 could be made. The metal plate has accurately spaced rows of small holes bored in it and is held between the two blocks of wood which are used as fences. Suitable holes are chosen and marked on the plate, and the templet is then applied to guide marks on the wood and the holes pricked through with a marking awl.

Dowels should be made of hardwood and may be purchased or made by splitting short lengths and roughly rounding them to size. They are then driven through a suitable hole in a dowel plate, Fig. 6, which will trim the dowel to the correct size. The dowel plate is made by

PLATE XI DOWELLING

FIG 1
DOWELLED ANGLE JOINT

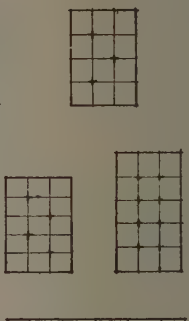


FIG 2
VARIETIES OF SETTING OUT

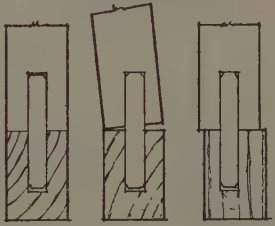


FIG 3
FAULTS

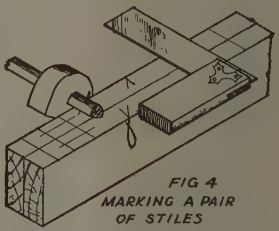


FIG 4
MARKING A PAIR
OF STILES

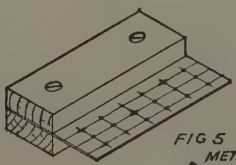


FIG 5
METAL TEMPLATE

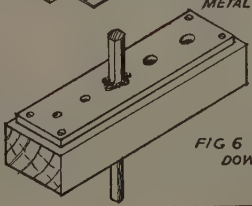


FIG 6
DOWEL PLATE

FIG 7
DOWEL
SHARPENER

screwing a piece of iron about 2 in. by $\frac{1}{4}$ in. to a block of hardwood and then boring a number of various-sized holes through both. The block of wood acts as a guide as the dowel is driven through.

The diameter of a dowel should not exceed one-third of the thickness of the piece into which it is glued, and the depth of the hole should be about four times the diameter. It is usual to have a small groove cut in the length of the dowel to allow the surplus glue to escape, but this is only really necessary for large dowels. It is better not to have any surplus glue as this can become a nuisance when it oozes out round the dowel and has to be wiped off before it sets. Very little glue is required to hold a dowel, and only the tip end should be glued. A stick which is smaller in diameter than the hole may be used to deposit glue inside the hole.

If the end of a dowel is bruised with the hammer and then driven home, the wood will absorb glue and tend to swell to a greater diameter, thus obtaining a better grip.

The dowel sharpener (Fig. 7) is used to reduce the end of the dowel slightly so that it will enter into the hole easily.

Dovetailing (Plate XII)

It is often said that dovetailing is a difficult business and only the expert can carry it through successfully, for the making of any joint can be difficult unless executed in the proper manner, that is, attention to the setting out and care in cutting to the line. There is usually a correct procedure when making a joint, so that if all these points are borne in mind, the dovetail joint can become one of the easiest to make. Plate XII illustrates some of the usual types of dovetailing that the joiner is called upon to make. That in Fig. 1 is the usual form of box dovetailing, and it should be noted that the pins which are formed on piece *A* are merely wedge-shaped tenons which fit into similar-shaped sockets. These pins are sometimes made very slender, but whatever size they are, when setting out, always start and finish with a half-pin, that is, the two outside pins which are bevelled on one

PLATE XII. DOVETAILING

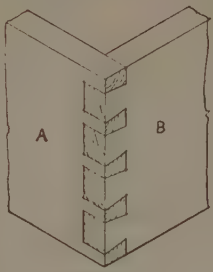


FIG 1 COMMON DOVETAILING

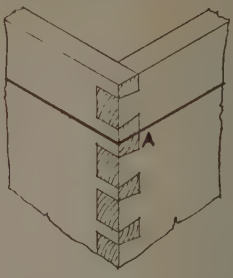


FIG 2 DOUBLE PIN (A) FOR CUTTING

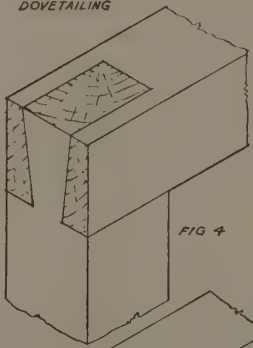


FIG 4

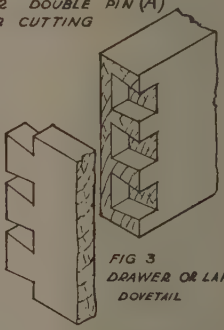


FIG 3 DRAWER OR LAP DOVETAIL

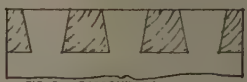


FIG 6 CARPENTERS DOVETAIL

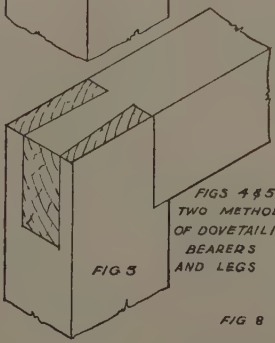


FIG 5

FIGS 4 & 5 TWO METHODS OF DOVETAILING BEARERS AND LEGS

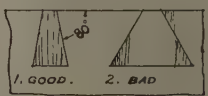


FIG 7

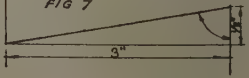


FIG 8

side only and have the narrow edge equal to that of a whole pin, which should be $\frac{1}{4}$ in. The sockets for the pins are cut in the piece *B*, the space between them being the dovetail, which should be made about three times the size of a pin.

When making a box which has a lid, it is usual to joint sufficient material for the full depth of lid and box, then to separate the lid from the box by saw-cutting. By so doing the dimensions of both box and lid are kept the same. Allowance must be made for a double pin, as at *A*, Fig. 2, to provide two half-pins after cutting, and it should be noted that the setting out for the lid portion shows one dovetail and two half-pins, which should always be the case where two narrow pieces are dovetailed together.

A similar arrangement is shown in a larger form in Figs. 4 and 5, and may be varied as shown to suit the type of work in hand.

Note the notching of the bearer on to the leg in Fig. 5 in order that the weight may be taken by the full width of the bearer and not merely the dovetail. The setting out of the dovetails for a box should be so arranged that as little end grain as possible will be showing to the front, as in Fig. 1 the piece *B* should be the front, so that only the ends of the pins will show. When it is not desirable that any end grain should show, as in the case of a drawer front, the lap dovetail is used. This is shown in Fig. 3 with the parts separated. The lap portion is left on the drawer front to hide the end grain of the dovetails.

The carpenter's dovetail (Fig. 6) has the pins and dovetails all the same size, and is considered to be the strongest form of dovetailing; consequently, it is used in the construction of heavy wooden tanks, etc.

The correct angle for a dovetail is 80° as indicated (No. 1, Fig. 7), and a method of setting this out is given in Fig. 8. By marking off these sizes on a board, a pitch of 1 in 6 or approximately 80° will be obtained, and a bevel can then be set to this angle.

Nothing is gained by using an acute angle as shown at

No. 2, Fig. 7; in fact, this will cause much trouble in trying to prevent the corners breaking off, due to the short grain (as indicated by the lines), and result in a weak joint.

Dovetail joints should be put together once only, that is, when they are finally glued, as they are partly dependent on the tightness of a good fit. Any preliminary trying out and knocking asunder will only spoil what might otherwise be a good joint.

There are two methods of making this joint: one is to cut the pins first and then mark the sockets from them, and the other is to cut the sockets first. In the first method the marking out may be done neater, but each piece must be dealt with separately, whereas by cutting the sockets first, a number of pieces may be dealt with in one operation, as shown in the photograph, Fig. 6. This is perhaps the better method, as the sockets are easier to cut straight and there is a saving of time. After sawing the sockets, the piece to contain the pins is fixed upright in the vice and the socket piece laid on top and held to the marks (see Fig. 7). The tip end of the saw is then entered into each saw cut and drawn sharply back, thus marking the position of the pins. The pins are squared down on each face and sawn, care being taken to saw on the waste side of the marks. The bulk of waste may be removed with a bow saw or compass saw as shown in the photograph, Fig. 8, and the remainder taken neatly to the gauge line with a bevelled-edge chisel working half-way through from each side. The sockets are also chopped out with a bevelled-edge chisel in a similar manner (see photograph, Fig. 9), the half-sockets of course being taken out with the saw.

Angle Joints (Plate XIII)

There are many ways of joining angles or corners together other than by dovetailing, and a few of these ways are shown in Plate XIII. Fig. 1 shows the plain butt joint, which is mostly used in inferior work, as the end grain of one piece is left showing. Gluing is not sufficient for this joint, so that

T.Y.J.—3 FIG. 6.

FIG. 7.

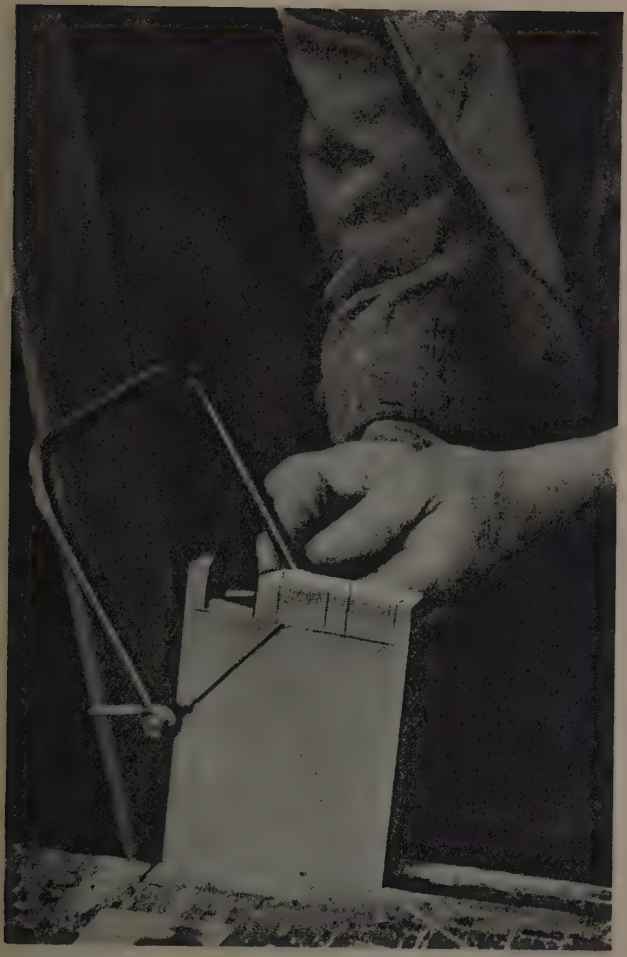


FIG. 8.

FIG. 9.

additional fastening is necessary in the form of nails and screws; glue blocks in the angles give added strength to joints of this type. The end of the piece *A* should be very carefully cut and tested for square, for if it is not square, the internal angle will not be a right angle, and any attempt to pull this right will only result in an open joint, which would be very weak.

These latter remarks apply to all joints of a similar nature, for if the jointed surfaces do not fit correctly, gluing surface is lost and the whole joint weakened.

Fig. 2 is a slight improvement, as more gluing surface is provided, the joint may be nailed in two directions, and less end grain is shown. The piece which fits in the rebate will withstand pressure better than the piece *A* in the butt joint would.

The mitred joint (Fig. 3) is used for the angle joint of skirtings or any place where it is not desirable that end grain should show. In itself it is not a strong joint and is often difficult to keep in position when nailing, but if it is grooved and a tongue inserted as shown in Fig. 6, the two pieces will be kept in position, additional gluing surface is acquired, and the joint is therefore much stronger.

Another method of strengthening the plain mitre joint is given in Fig. 10. After the glued joint has set, a number of inclined saw cuts are made and thin slips of wood are glued and inserted. The dovetail effect of these keys will help to prevent the jointed pieces from pulling apart.

Fig. 4 shows the butt joint further strengthened by the addition of the cross tongue, and Fig. 5 is a variation of the rebated joint in Fig. 2, the lap portion being mitred to avoid the end grain showing. This is quite a good form of mitre joint not difficult to make, but it must be secured with nails. All the foregoing joints are suitable for edge joints as well as corner or angle jointing of boards, but Figs. 7, 8, and 9 are intended for edge joints, and may be used for jointing the angles of panelling, etc., in good-class work, where fixing is by glue only. The staff bead and ovolo are worked

PLATE XIII. ANGLE JOINTS

FIG 1
BUTT JOINT

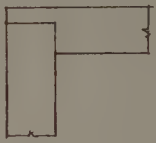


FIG 2
REBATED

FIG 3
MITRED

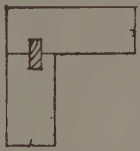


FIG 4
CROSS TONGUED

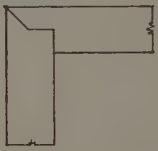


FIG 5
MITRED & LIPPED

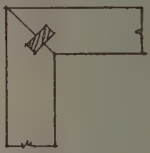


FIG 6
TONGUED MITRE

FIG 7
STAFF BEAD
& TONGUE

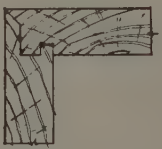


FIG 8
TONGUED & LIPPED
MITRE

FIG 9
TONGUED & OVOLO
MOULDED

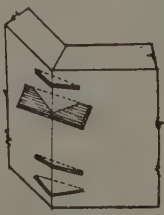


FIG 10
SLIP KEYS OR
FEATHERS

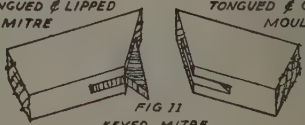


FIG 11
KEYED MITRE

FIG 12
DOWELLED MITRE

on to hide the joint and to avoid the sharp corner as in Fig. 8.

Figs. 11 and 12 show two forms of mitre joint for flat pieces of wood as in framing. The cross-grained key in Fig. 11 may be taken right through the mitre or stopped as shown if it is not required to be seen on the outer edges. The dowelled mitre is quite a strong joint and very useful for polished work where the edges must be kept clean and free of any end grain.

Clamping (Plate XIV)

A wide board is sometimes required when making, for example, a box lid or a drawing-board. This may be in one width, or a number of narrow boards jointed together. However, a considerable amount of shrinkage and warping can take place in a wide board; therefore, in order to keep the board straight and prevent warping, it should be clamped by any of the methods shown in Plate XIV.

One of the commonest forms of clamping is shown in Fig. 1, and is used in its crudest form for a batten door or when a number of boards are cramped together and a piece known as a ledge is nailed on to hold them together. If carried out as shown in Fig. 1, this can be one of the best forms of clamping if appearance is not the governing factor. The ledges should be thicker than the board to which they are screwed, and slots should be made for the screws instead of holes. Slotted metal plates, as shown, are recessed in the ledge, and special flat-headed screws are used (see small section below Fig. 1). Should any movement take place in the board, the screws are free to move in the slots and splitting of the board is prevented. When the clamps are fixed on the ends of the board and all faces are level, this is known as flush clamping, one of the best forms being shown in Fig. 2. It is better to groove the clamp and work a tongue on the board than groove both pieces and let in loose tongues, as this is not so strong. Should shrinkage take place in a board clamped as in Fig. 2, there is a chance of the

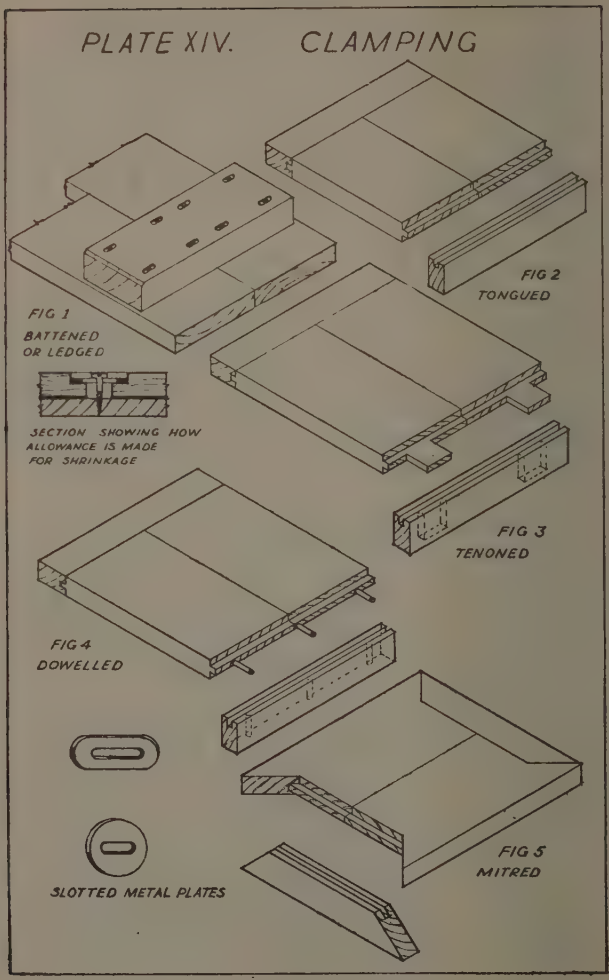


PLATE XIV. CLAMPING
FIG 1
BATTENED
OR LEDGED
FIG 2
TONGUED
SECTION SHOWING HOW
ALLOWANCE IS MADE
FOR SHRINKAGE
FIG 3
TENONED
FIG 4
DOWELLED
SLOTTED METAL PLATES
FIG 5
MITRED

glue giving, in the outer ends of the tongued joint, before the board will split. The writer has seen this happen to an old drawing-board which has shrunk considerably, but is still perfectly flat and free from splits with the clamps still firmly fixed.

More elaborate and stronger forms of flush clamping are seen in Figs. 3 and 4, but in both cases the board is firmly held either by the tenons or the dowels, and unless the timber is very well seasoned, shrinkage will cause splitting. The mitred clamping in Fig. 5 may be used in good-class polished work, where the end grain of the clamps should be avoided. Here again the board is firmly held and could not shrink without splitting.

As mentioned earlier, wide boards are often used for this type of work, although the samples shown in Plate XIV are shown jointed. This is done with a view to economy usually, as very wide boards are costly. There is also the added advantages that warping and shrinking will be reduced to a minimum when a number of narrow boards are used, especially if the grain is arranged suitably (see chapter on Timber).

Jointing to Increase Width (Plate XV)

When assembling and jointing a number of narrow boards to produce a wide surface, some thought should be given to the type of joint best suited for the job. A number of these joints are shown in Plate XV both pictorially and in section, and at the bottom of the plate is a section through four narrow boards showing how the grain should be arranged with the heart side of the boards alternatively up and down. This is done to minimise the effect of warping, as one board will help to counteract the next, and warping will not be so apparent as when they all tend to warp in the same direction.

The Butt Joint, *A*, is the most commonly used, and is essentially a glued joint, being made either as a rubbed joint or cramped. To make a rubbed joint, the meeting edges must be planed to fit each other for the full length. This is

done by planing the edge of one board as straight and square as possible, using a trying plane or a longer plane known as a "jointer," taking care to see that the iron is sharpened perfectly straight across. The next board is then planed to fit, so that when the two are assembled, no light can be seen through the joint, and the two faces fit a straight-edge held against them; this is known as "shooting" the joint.

Another method is to place two boards together in the vice with their faces opposed and the joint edges uppermost. Any tendency to plane the edges out of square will not matter then, for when the joint is together, any bevel on one board will be countered by a similar but reverse bevel on the other. *A plentiful* supply of hot glue is spread on both edges at the same time; they are then brought together and rubbed until the glue begins to pull. At this stage the boards should be guided into their final position and left alone until the glue sets. The rubbing of the joint spreads the glue evenly, forcing out any which is superfluous and at the same time filling the pores of the wood, forming a key and driving out the air, for this is the essence of a good glue joint.

When cramping a joint it will be noticed that the ends of the joint become slack and will eventually open, so to counteract this the joint should be shot slightly hollow to prevent this springing at the ends.

The Tongue and Groove Joint, *D*, is not suitable for gluing, as it is difficult to produce a good fitting joint; it is better where ledges are being used.

A better form of tongued joint is the groove and fillet at *E*, where each board is grooved and a loose tongue inserted. The grooves should be made before the joint is finally shot, so that any rubbing from the use of the plough will not spoil a good fitting joint.

Tongues are either a straight-grained strip of wood, or a number of short pieces which have been cut across the grain from a thin board, either square across or diagonally. They are used to provide a greater gluing surface, and should

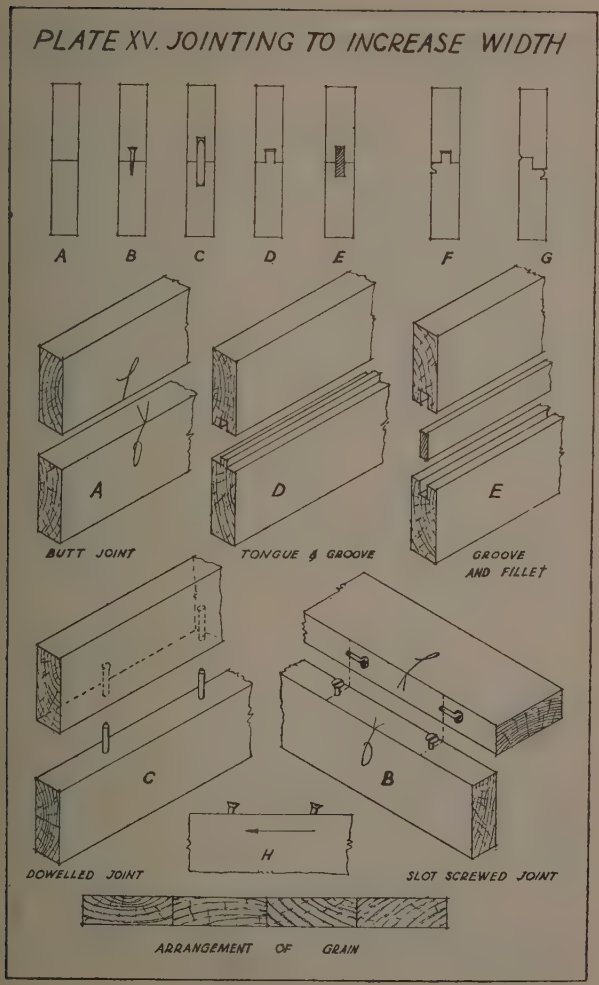


PLATE XV. JOINTING TO INCREASE WIDTH
A
B
C
D
E
F
G
A
D
E
BUTT JOINT
TONGUE & GROOVE
GROOVE AND FILLET
C
B
H
DOWELLED JOINT
SLOT SCREWED JOINT
ARRANGEMENT OF GRAIN

not be made so slack that they do not fulfil this function. On the other hand, if made a tight fit, the application of the glue will cause swelling and prevent the joint from being rubbed as it should be.

Cross-grained tongues are very useful where there is likely to be any strain on a joint; but in the case of a glued and rubbed joint, the long-grained straight fillet is quite satisfactory and much easier to manipulate than a number of short lengths of cross tongues.

The Dowelled Joint, *C*, is a strong joint, as the gluing surface is increased by the dowels. Cramps are required to force out the superfluous glue, and for this reason the joint must be shot hollow and have extra dowels just near the ends to help stop the tendency for the ends to spring, which does not occur until some time after the glue has set. Always use plenty of cramps, which should be applied from opposite sides to prevent the boards from buckling.

The Slot Screwed Joint, *B*, should be shot hollow for the same reason as the dowel joint, as it may be put together with glue. If used for external work, or draining-boards where it is in contact with water, it is an excellent joint providing brass screws are used and the joint is made with fairly thick white-lead paint.

To set out for the screws, place the boards together with the edges uppermost and square across lines about 10 in. or 12 in. apart. Next intersect these lines with a centre line gauged from the face of each board.

At the intersection of these lines on one board a stout screw is inserted to the full depth of the thread, while at the opposite intersection a hole is bored equal in diameter to that of the screw shank. About an inch away a second hole is made big enough to take the screw head and slightly deeper than the projecting screw. The two holes are then connected by a slot equal in width to the diameter of screw shank. When the two boards are cramped together it will be found that the ends do not come in line, the difference in this case being 1 in. If one board is held in the vice and the

other driven along until the ends are level, the screw heads will cut a dovetailed chase for themselves, while the stems move in the slots; thus the joint is held by the screws.

The small diagram at *H* shows the screws slightly tilted, so that when driven the tendency will be to bite deeper into the wood and so pull the joint tight.

The section at *F* shows the matched or tongue and groove joint with the addition of a bead which is put on to hide the joint. The bead should be worked on the tongued board where it does not weaken the edge, as it would if worked on the grooved board.

A V Joint is sometimes used, being formed by chamfering each board as shown at the rebated joint at *G*. A bead is also shown here in the most suitable position. The rebated joint (*G*) is not a good one where strength is required.

CHAPTER IV

IN THE WORKSHOP

Saws and Sawing

This chapter is devoted to what is more or less a collection of hints and tips on the handling of tools in the workshop. The first and foremost tool in the workshop is the saw. It may seem at first that sawing to a straight line is easy, but that is not so, and perfection only comes with experience. When starting to use the saw, the thumb may be placed against the side of the blade as a guide and the saw drawn gently upwards a few times before attempting to push it downwards, this will form a small groove to guide the saw and prevent it from jumping and jagging either the wood or the operator's thumb. This process will be seen in the photograph, Fig. 10, which shows the start of a cut with the rip-saw, and also in Fig. 11, where a short end is being cut off a board. The saw should be gripped firmly with the index finger outstretched to serve as a guide (see Fig. 12), and the arm and saw should be kept in a straight line. The body should be poised in a comfortable position and the saw used steadily and firmly without being forced. Any attempt to force the saw, thinking that it will cut quicker, will lead to disillusionment and produce out-of-square or twisted cuts.

The tenon or back saw is shown in use in the photograph, Fig. 5. You should notice how the bench hook is used to steady the work while the shoulder is being cut.

Fig. 4 shows the position when ripping down a tenon with a rip-saw, while in Fig. 6 the dovetail saw is being used. The coping saw may be used to advantage, as seen in Fig. 8, for cutting out the waste when dovetailing. The saw for cutting large sweeps or quick curves is the bow saw, and is seen in use in Fig. 13.

On all occasions when sawing, complete control over the

FIG. 10.

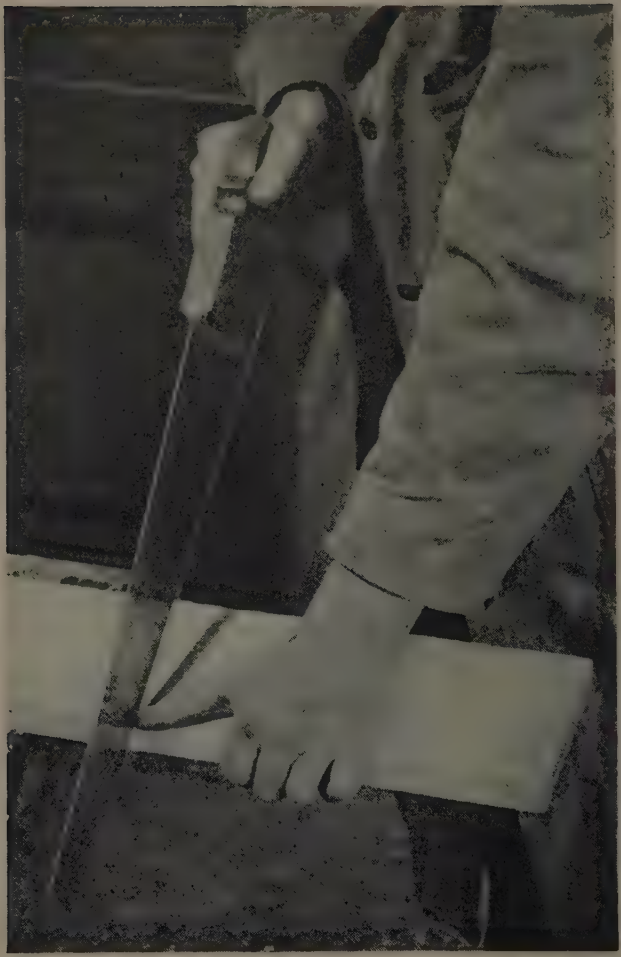


FIG. 11.

saw is necessary, and do not forget to cut on the waste side of the line.

Always use the right type of saw for the job and see that it is sharpened and set properly and prevented from rusting when lying up. Setting and sharpening a saw is a tricky job for a beginner and should be left to the specialist, who will do the job for a small sum and save a great deal of trouble and perhaps a ruined saw which would have to be recut. However, a few hints as given here and some practice on an old saw should soon give sufficient confidence to tackle the job properly.

Setting is the act of bending the teeth alternately to right and left, which will result in a saw cut slightly wider than the thickness of the saw blade, so reducing friction and allowing the saw to move freely. As little set as possible should be given, especially when working in hardwood, but with wet softwood more set is required, even though the saw will not cut so smoothly. If the teeth are uneven, they should be levelled by rubbing an oilstone or fine file along the edge just sufficiently to bring them all to the height of the lowest.

FIG. 12.

FIG. 13.

The next step is to put on the set, which may be done with one of the many special spring-plier saw sets made for this job.

The saw is then held between two strips of wood in the vice, and filing commenced with a triangular saw file. The position of the file is dependent on the shape of the teeth (see Saws, Plate III), but once fixed the position must be maintained throughout the sharpening. Start at the point of the saw and file the leading edge of each tooth which is bent towards the near side of the saw, at the same time touching the back of the adjacent tooth and filing down into the gullet between the teeth. When alternate teeth have been filed along the near side, turn the saw round and repeat the process from the other side.

For a cross-cut saw the file should be held at an angle of 45° to the blade and pointing towards the handle of the saw.

The amount of hook in the teeth will determine whether the top of the file should be held level or tilted over.

With a saw in good condition a couple of even file strokes on each tooth would be sufficient, but if much levelling has been done, some teeth will require more filing than others. This is when great care should be exercised or the teeth will soon be all different shapes.

When sharpened, the saw should be laid down flat and the oilstone passed lightly over the sides of the teeth to remove any burrs or unevenness of the set.

Planes and Planing

The bench planes shown in Plate IV form a most important part of the joiner's kit, and they should be thoroughly understood from the time they are bought. When buying you should check the end grain and see that the annual rings run parallel to the sole of the plane, with the medullary rays running from top to bottom. If the grain is curly, or running diagonally across the end, the plane will not wear so well, and will always be liable to twist, however many times the sole of the plane is trued up.

Test the iron to see if it sits firmly on the bed, and see that the wedge fits evenly and is not just tight on one point. These latter faults are more likely to occur in an old plane and will cause vibration or chattering of the iron. They should be remedied, not by cutting the bed, but by gluing thin packings under the iron and then by easing the tight parts of the wedge with glasspaper.

If the shavings tend to choke up the mouth of the plane when it is in use, do not poke about in an attempt to clear the shavings, but remove the wedge and iron and look for any of the following faults: roughness on the mouth, throat, back iron or wedge, a badly fitting wedge or back iron, or the irons badly set. The roughness should be removed with a fine file, glasspaper or emery cloth, and the back iron checked to see that it fits closely against the cutting iron. It is surprising how much trouble can be caused by even the slightest amount of space between these irons.

On no account must the mouth of the plane be cut and widened, as it will be the correct width when bought and will gradually widen as the plane wears down. New wooden planes should be impregnated with raw linseed oil, which in time causes a glossy surface on the sole, lessens friction, and makes the plane work easily. It also adds weight to the plane, which does not require so much pressure on to the work when in use. The plane and wedge may be immersed in a tank of oil, or the mouth may be stopped with putty and the throat kept filled with oil until sufficient has been absorbed.

As already mentioned, the angle of the bed of a plane to the sole is usually 45°, but certain planes have a bed angle of 60° or more, which is known as the " cabinet pitch." Planes with this steeper angle are used for smoothing rough and curly grained woods, when more of a scraping action is required in order not to tear the grain. Moulding and other single-iron planes are often made with this steeper angle to compensate for the lack of a back iron.

In such planes as the block and shoulder planes which

are used on end grain, the angle of the bed is very flat, 15° or even less. In flat-pitched planes the iron is reversed, so that the sharpening bevel takes the place of a back iron.

The back iron is used in the larger planes to prevent the tearing of the fibres, its function being to break up the shaving and curl it towards the front of the plane as soon as possible. For bad curly-grained woods the back iron should be set very close to the cutting edge, and the projection of the cutting iron, known as the bite, should also be kept fine.

All cutting irons should have a grinding angle of 25°, that is, the angle between the ground face and the face of the iron, and a sharpening angle of 35°.

When releasing the wedge and iron of a trying or jack plane, it should be held with the fingers on the sole of the plane and the thumb in the throat. A sharp blow is then given with the hammer on the top face of the plane and as near to the front end as possible (see Fig. 14). This will slacken the wedge, and the pressure of the thumb will pre-

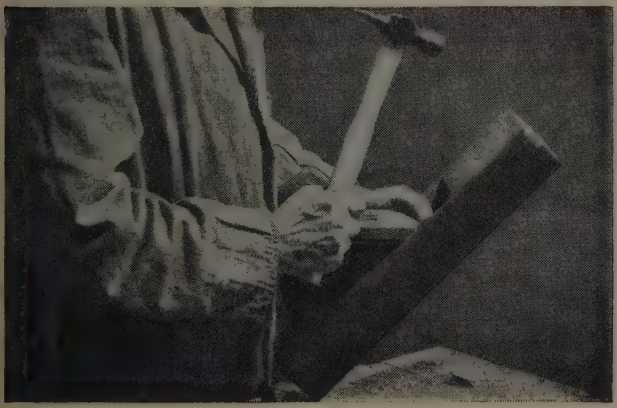


Fig. 14.

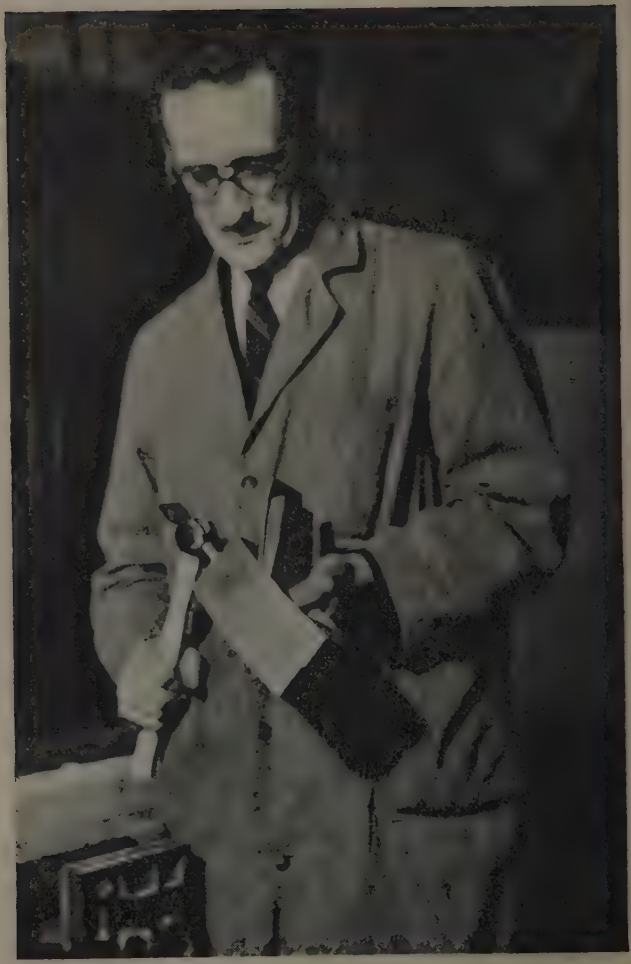


FIG. 15.

vent both the iron and wedge from jumping out. A plane should never be struck while being held by the handle, as there is a likelihood of the handle breaking.

The smoothing-plane wedge is released by hitting on the back of the plane, as in Fig. 15, this being the only plane to be treated in this manner.

Rebate and moulding planes should not be hit on the body, as this will not slacken the wedge. Support the iron and wedge by holding the plane as in Fig. 16 and give the specially shaped wedge a sharp tap with the hammer as indicated.

When replacing the wedge of any plane, it need not be driven hard, but should be gently and firmly tapped home.

When separating the irons for sharpening, they should be held on the edge of the bench and unscrewed as shown in Fig. 17. This method provides better control than if the irons are held in the hand, and there is less danger of the screwdriver slipping and causing damage.

When sharpening, the iron should be firmly gripped in both hands and laid on the stone with the ground surface

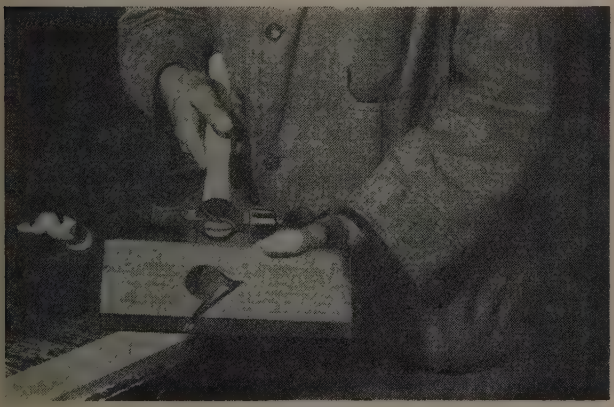


FIG. 16.

touching (see Fig. 18). If the hands are lifted slightly, this will give the sharpening angle, which should be maintained throughout the sharpening. To test an iron, hold it to the light, and if the edge appears as a bright white line, then the iron is blunt. If, after rubbing down on the oilstone, a slight burr is felt on the flat side, this should be removed by placing the iron perfectly flat on the stone and giving one or two gentle rubs. On no account should any bevel be given to this side of the iron. The edge may be tested by gently touching with the thumb, and if sharp, will give the impression that it is sticking slightly to the skin.

A Jack Plane is used for rough work, so the iron is ground slightly convex (see Plate IV), and the back iron is set about $\frac{1}{8}$ in. back from the cutting edge. The trying and smoothing irons should be ground straight across and the corners slightly rounded off to prevent marks being left on the wood (see Plate IV). As these two planes are for finer work, the back irons are set nearer to the edge of the cutting iron, the amount of set being adjusted to suit the type of wood to be planed.

FIG. 17.

After sharpening, the irons are put together and the screw tightened. They are then inserted in the plane, with the back iron uppermost and the wedge held in position by the thumb as before. The amount of projection is checked by sighting down the sole of the plane, and the wedge gently tapped home (see Fig. 19).

Planing

One of the most important operations the joiner has to carry out is to " true up " a piece of wood. This is known as " facing and edging," and the future success of most pieces of work is dependent on this preliminary operation being properly carried out. It is not sufficient to just plane up the four sides of a piece of wood, as it may be twisted or " winding," and should be " taken out of wind," so that it will lie flat on a level surface without rocking on the opposite corners as a twisted board would do. The finished piece should be perfectly straight in all directions, parallel in width and thickness, and with edges square to the face. This is achieved by carrying out the following sequence of operations.

FIG. 18.

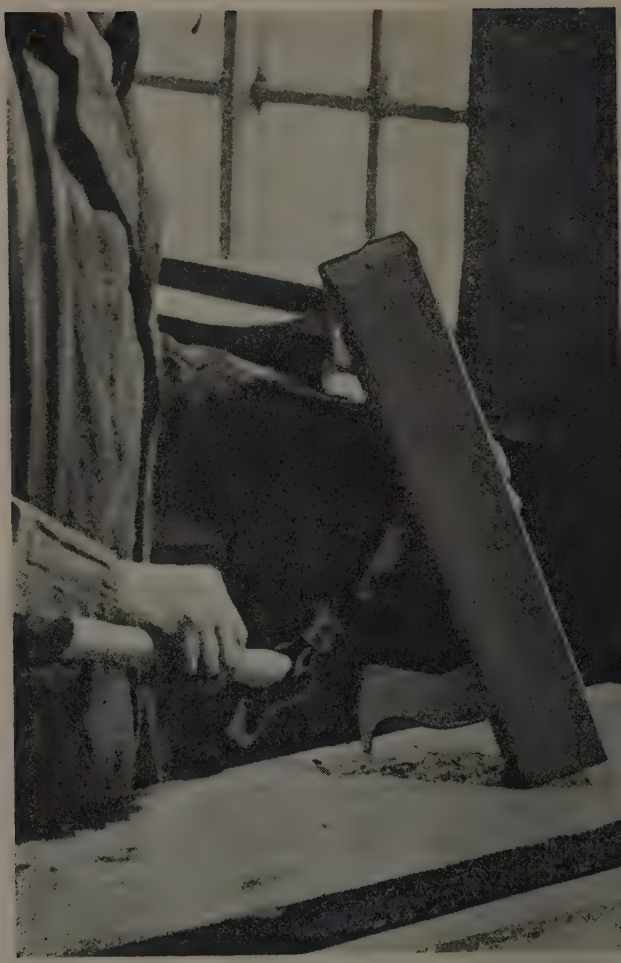


FIG. 19

First choose what appears to be the best face, and in so doing take notice whether it is twisted, bent in the length, round or hollow across the face. Next plane off the rough surface with the jack plane, taking off as little as possible, but at the same time attempting to straighten the surface by taking more off the high parts. At this stage a few words on the handling of the plane may be beneficial: note the position of the hands in the photograph, Fig. 20. The body should be nicely balanced with the left foot forward, and at the start of the stroke downward pressure should be applied on the front of the plane with the left hand. As the plane moves forward, this pressure should be gradually transmitted to the back of the plane via the right hand, as by this means the plane will be kept flat on the timber throughout its entire stroke. The right arm and shoulder should be in line with the plane in order that the weight of the body will be behind and helping the right arm as the plane is being pushed.

As planing proceeds, the material should be checked to see if it is straight across the face. This may be done with a try square or by using the edge of the jack plane. Next test

FIG. 20.

for winding as shown in Fig. 21, by placing two parallel strips of wood known as " winding sticks " across the face of the timber, one at each end.

Their top edges are then sighted and if parallel all is well and the timber is " out of wind." If winding or twisted, the sticks will denote which are the high corners, and these should be planed down until the sticks indicate that the twist has been taken out. After this, straighten the piece from end to end with the trying plane and test with a straight-edge.

Short pieces of wood may be tested for straightness by sighting the edges, especially after some experience has been gained. When finished, the face is indicated by a face mark, which is a loop with a long tail leading off to what will be the face edge (see Plate XV). This edge is then cleaned up and planed straight and square to the face, being tested with the try square. When correct, it is marked with a V pointing to the face; this is known as the face edge mark.

Fig. 22 shows the trying plane being used to straighten the edge of a thin piece of timber. In this case the fingers

FIG. 21.

of the left hand are being used as a guide to help to keep the plane straight and upright.

A marking gauge is now set to the width, making this measurement slightly full to allow for a final cleaning off, which would otherwise make the timber slightly under size. This applies also when gauging for thickness.

The edge is then planed down to the gauge line, and carefully checked with the try square to see that it is square off the face.

The marking gauge is set to the thickness, and lines gauged along each edge, working from the face of course.

The last face is now planed down to the gauge lines and checked across with the plane or try square to see that it is not planed hollow. The piece of timber is now ready for setting out.

Gauging

Marking and mortise gauges have already been mentioned, but there is still another, the cutting gauge, which is slightly different, having a small knife held in by a wedge, in place

FIG. 22.

of the pointed spur. This gauge is used for gauging across the grain, but the method of handling is the same as for the other two. The stock slides along the stem and is held in position by the thumbscrew. When gauging, the index finger should be placed round the top of the stock and the remaining fingers round the stem. The thumb is placed on the back side of the stem as near to the spur as possible.

The stock of the gauge should always be applied to the working face or working edge, with the farthest corner of the stem and the spur resting on the material.

Starting from this position, the gauge should be moved away from the operator, with sufficient pressure on the stock to keep it against the material. Undue pressure should not be used, and the spur need not be forced into the wood. Fig. 23 shows the mortise gauge in use, and will help to illustrate the handling of a gauge.

Rebating

A rebate is the recess taken out of the edge of a piece of wood and sometimes called a " Rabbet " or " Rabbit." Examples of the rebate are : that part of the door frame in which the door fits, or the recess in a window sash which contains the glass. The two faces of a rebate are usually parallel to the faces of the piece of wood.

To form a rebate of the normal size, first gauge lines for the correct width and depth, using the face and face edge of the wood to gauge from. Next fix a straight lath to one of the gauge lines by lightly nailing, or with small G cramps if the surface must not be damaged. This will serve as a guide for the rebate plane, which is then used to remove the waste, care being taken when planing to see that the plane is kept upright and the rebate square to the faces. The photograph, Fig. 24, shows a rebate being cleaned out after the strip has been removed. Rebates which are too wide for the rebate plane may be worked by running a few grooves with the plough plane to the correct depth, and then cleaning out the bulk of the waste with mallet and chisel. The

FIG. 23.

internal angle is cleaned out with the rebate plane and the rest of the width levelled with the jack plane. There are occasions when very large rebates can be built up by fixing together two or more pieces, sooner than cut away a large amount of wood from the solid.

A rebate on the end of a piece of wood may be seen in Fig. 2, Plate XIII. This rebate is formed by sawing across the grain and taking out the waste with a chisel. The surfaces are cleaned off to the gauge lines with a rebate or a shoulder plane.

Chiselling

The chisel is a very useful tool, and is used constantly by the joiner, but it can be dangerous in the hands of the novice or when used carelessly. It should not be thrown down amongst other tools where the edge will be damaged, nor should it be allowed to roll off the bench.

When in use, chisels and gouges should always be held in such a way that they are under control, as in Fig. 1, where it will be observed that, although the chisel is held in one

FIG. 24.

hand, the fingers of the other hand are putting on the brake, so to speak, and allowing the chisel to cut just so much and no more. A silly mistake which is so often made, even by experienced men, is to attempt to use the chisel with one hand while the other holds the piece of wood, usually in front of the chisel. As the chisel is no longer under proper control, a slight slip can result in a nasty gash to the other hand. Fig. 25 shows the method of cutting downwards: the index finger of the left hand circles the blade and guides the cutting, the chisel being firmly held in the right hand, and downward pressure is applied by the operator's shoulder. With work of this nature, i.e. rounding or shaping a corner, chiselling should commence at the edge of the board and work round to the end, that is, with the grain, otherwise the corner of the chisel will bite into the grain and split the wood. The type of work shown in the photographs Figs. 1 and 25 is known as "paring," and is usually carried out with bevelled-edge chisels, as these are thinner than firmer chisels and overcome the resistance of the wood more easily. Firmer chisels are used for heavier work and should be hit with the mallet; in fact, the mallet should be used on all chisels and gouges whenever necessary, and not the palm of the hand, as this bad habit can lead to permanent injury of the tendons and cramping of the fingers.

The Spokeshave is very useful on curved surfaces where the plane and chisel cannot be used (see photograph, Fig. 26, which illustrates this tool in use). Note the direction in which it is being used away from the operator and the grain of the wood.

Chamfering is the forming of a bevel in place of the usual sharp angle on the corners of a piece of wood. It is done to enhance the appearance of the work, or to prevent the sharp arrises from being damaged. The gauging for a chamfer should be done with a pencil only, as the marking gauge would leave a deep cut which could not be removed when chamfering and would remain unsightly.

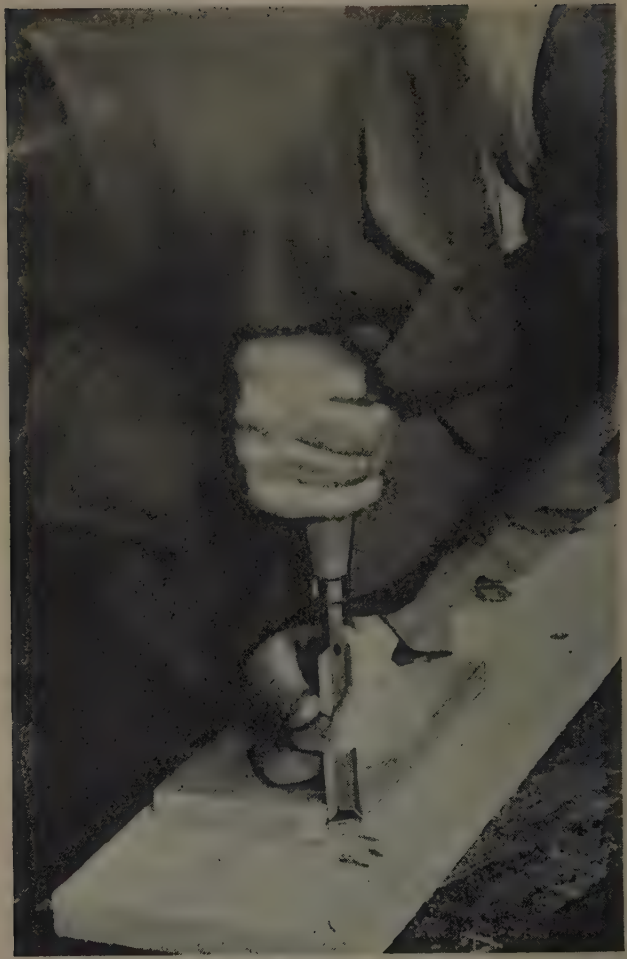


FIG. 25.

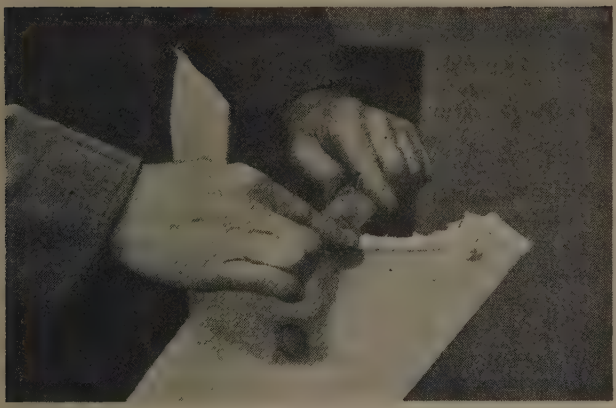


FIG. 26.

Boring

Among the bits shown in Plate VII is the bradawl, which is a most useful tool. At least three different sizes should be available for use when nailing or screwing. Fairly large nails should be given a start by boring part-way with the bradawl in softwoods, especially when nailing near the end or edge of a piece of wood. In hardwoods only small holes are made with the bradawl, holes for large nails and screws being made with the brace and bit.

The end of the blade should be sharpened to a chisel edge and applied to the wood with this edge across the grain, a slight to-and-fro movement being used when pushing the bradawl into the wood. This enables the blade to cut the fibres and prevent splitting, which would occur if the blade was pushed in with the grain, and used as a wedge. Large bradawls may be tapped in with a hammer, but the rotary movement must be used in order to keep the blade free in the hole and allow easy withdrawal. Gimlets need not be forced into the wood, only slight pressure being needed, as

their shape is such that they will be drawn into the wood. They should be turned constantly in the one direction and withdrawn at intervals, to remove the waste core, by turning in the opposite direction and exerting an upward pull. If a good stock of brace bits is kept, the gimlet is not really needed, but it sometimes conveniently replaces the smaller brace bits which are so much dearer.

The centre bit, if kept sharp and in good condition, will bore a hole cleanly and easily, but some thought must be given to the method when boring through a piece of wood. Firstly, the hole should be bored until the centre point of the bit is just breaking through the opposite side. Withdraw the bit, turn the board over and, using the small hole as a guide for the centre point of the bit, with a few turns describe a circular cut with the nicker. Turn the board back again and complete the boring, when a thin circular disc will fall out of the hole without any bursting of the fibres.

When using the brace and twist bit to bore rather deep holes, the direction of the bit should be carefully checked at the start. This is the critical time, for if the bit does not start in the right direction, any attempt to right it afterwards will result in a bent or broken bit. The bit is guided by sighting either with the try square or small straight-edges. The operator must stand in a suitable position while boring in order to do this sighting.

When a number of holes are required to a certain depth, such as for dowelling, a depth gauge may be made for the bit. This is a small block of wood with a hole bored through it to enable it to slide on the bit. It is held in position by a blunt screw which grips the stem of the bit. A simple method is to wrap a piece of white paper round the bit to the required height and fix with glue.

CHAPTER V

SETTING OUT

HOWEVER small or unimportant a job may seem to be, it should be " set out " first. This means that full-size drawings should be made which will serve as a guide when marking out and working the timber. These drawings should be so arranged that each piece of wood required in the job may be seen and measured in length, width, and thickness, and all mouldings, grooves, rebates, mortises, etc., indicated in their correct places.

It is not necessary to repeat a moulding section in detail, providing it is correctly drawn once to act as a guide. All the required information is usually found by drawing vertical and horizontal sections of the work, but in the case of splayed or circular work, it is necessary to draw an elevation. When setting out, it is of the utmost importance that the work is carried out carefully and accurately, as the finished job is dependent on the designing and thought which go into the original setting out. Sometimes the setting out is done direct on to the timber, but this is bad practice and often leads to mistakes and slovenly work.

Setting out is done on thin boards of a length and width to suit the particular job. They should be made from a softwood which is free from knots and shakes, and has a smooth, even-textured grain. It is an advantage to whiten setting-out boards with a coat of whiting to which a little glue size has been added to bind it. This enables the drawing to stand out clearly, and when finished, a wipe over with a brush and clean water will remove the drawing and restore the board to its original whiteness. When the board is dry, a gentle rub over with fine glasspaper will provide a nice clean surface on which to draw.

To remove a drawing from a board which has not been whitened, the surface must be planed down. This reduces

the thickness of the board, and can often be a laborious procedure, especially when working on plywood.

It will be noticed in Plate XVI that the term " rod " has been used for the boards, as it was thought advisable to point out that this word is often used in place of " setting-out boards," no doubt because it is easier to say.

The true setting-out rod is a length of square-section timber about an inch square which has been planed on all four faces. The main setting-out lines, such as overall lengths and widths, mortises and shoulder lines, are marked out on these faces, and the rod is then used, transferring these marks on to the timber. For this purpose the rod is much more convenient than the board, but when complete sections and widths are required to be clearly seen, the rod would be useless.

All lines should be drawn with a pencil and not gauged with a marking gauge or cut in with a knife. In the case of the door (No. 1, Plate XVI) the first lines to be squared across would be those representing the overall height. Two lines would then be drawn parallel to the edge of the board, their distance apart being equal to the thickness of the door. Inside these, two more parallel lines will show the position and thickness of the panels, also the position of the mortises and tenons which are kept in line with the panel grooves.

Next mark off the position of the rails according to the type of door, in this case a three-panelled door with a square-top panel. It will now be found necessary to set out the width in order to find the size of the top panel, for this determines the position of the middle rail which must be fixed so as to ensure that the height of the panel is the same as the width. Lines are now squared across inside those of the rails, to fix the depth of the panel grooves and incidentally the position of the mortises, as allowance must be made for the mortises and tenons to be kept clear of the grooves. The remainder of the width of the rails is now divided up for the mortises (see notes on haunched and divided tenons). Half the remaining width of the top rail is used for the

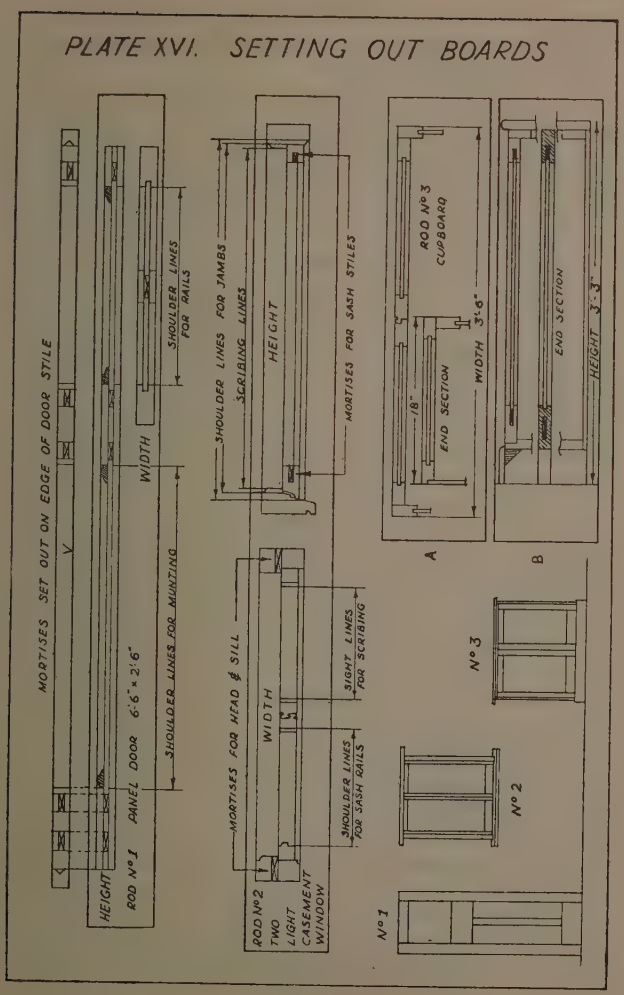


PLATE XVI. SETTING OUT BOARDS
MORTISES SET OUT ON EDGE OF DOOR STILE
ROD Nº 1 PANEL DOOR 6'-6" × 2'-6"
HEIGHT
WIDTH
SHOULDER LINES FOR RAILS
SHOULDER LINES FOR MUNTING
ROD Nº 2 TWO LIGHT CASEMENT WINDOW
MORTISES FOR HEAD & SILL
WIDTH
SHOULDER LINES FOR SASH RAILS
SIGHT LINES FOR SCRIBING
SHOULDER LINES FOR JAMBS
SCRIBING LINES
HEIGHT
MORTISES FOR SASH STILES
ROD Nº 3 CUPBOARD
18"
END SECTION
WIDTH 3'-6"
A
END SECTION
HEIGHT 3'-3"
B
Nº 1
Nº 2
Nº 3

mortise, while the remaining portion of the middle and bottom rails is divided into four parts and set out as shown on the edge of the door stile.

The length of the munting will be found on the height rod, being the exact distance between the bottom and middle rails, plus an allowance of about 2 in. each end for the tenons. The mortises for the munting and the shoulder lines for the rails are taken from the width rod, as will be seen in Plate XVI.

When setting out for a window frame such as that shown on Rod No. 2, two measurements are first required. These are known as the " daylight sizes " of the opening in the wall, the width being the distance between the brick jambs and the height taken from the top of the stone sill to the underside of the head. These two measurements are first set out on the board, and the window frame then drawn in, so that when finished it will occupy the desired position in the opening. In the case of a solid window frame, the jambs are tenoned into the head and sill; therefore, the width rod will show the position of the mortises. The shoulder and scribing lines for the ends of the jambs are taken from the height rod, and it should be noted here that, owing to the sill weathering, the lower end of the jamb will have to be scribed to fit, thus causing two distinct shoulder lines, inside and outside, which are not opposite. The top end of the jamb is similarly affected, this being due to the cavetto moulding which has been run round the outside of the jambs and head.

The setting-out lines for the two sashes are indicated, also a form of weatherproof joint between the two meeting stiles which is known as a " hook joint."

Rod No. 3 shows a cupboard with two doors, drawn out to give the length, depth, and height, that portion at *A* being the length, with the depth shown on the end section which has been turned round for convenience. It is not necessary to show the depth of the cupboard on Rod *B*, but the height and general construction are shown with the drawing broken to accommodate a vertical section through the end framing.

CHAPTER VI

CARCASS WORK

THE term " carcassing " may be applied generally to the constructing of the main framework of such fitments as cabinets, cupboards, desks, and counters, etc. This carcass work may be panelled framing or solid boards, dependent on the class of work or the finished appearance required. The main joint used is the dovetail joint, which is most suitable where there is a tendency for the angles and corners to pull apart. Carcass work is structurally weak and often subject to a considerable amount of racking, therefore some thought should be given to the design and construction of the best type of joint and to the use of glue blocks. Shrinkage of the timber should also be taken into account, wide boards being allowed to move freely and not held so that shrinkage will cause splitting.

Designs for cupboards and cabinets are many and varied, but fundamentally the principles of construction do not vary much. A few of the general methods of jointing are depicted in Plate XVII. The section of a simple cupboard is shown in Fig. 1, and details of the joints used are shown to a larger scale in Fig. 2. The carcass may be likened to a box formed of two ends, a top and bottom, and a back. The front is filled in with the doors, and shelves may be fitted inside. The bottom is finished off by mitring a plinth board round the front and two ends. If the depth of the cupboard, from back to front, is in excess of 11 in., it may be more economical to joint up boards to obtain the required width for the sides, top, bottom, and shelves.

The housings for the bottom and the shelves should stop short of the front edge by about $\frac{1}{2}$ in., thus causing a small portion of the shelf to be shouldered (see Fig. 2).

A 3-in. by 1-in. rail is dovetailed into the ends at front and back, and a fillet screwed on each end to prevent warpage.

The top is held down by screwing through these rails and fillets, and it should be noted that the screw holes are elongated or slotted; this is to allow the screws to move with the top should any shrinkage take place. The ends are rebated to take the back, which may be plywood, narrow matchboarding, or the panelling as shown in Fig. 3.

The end of one of the muntings is shown in Fig. 4, notched to fit over the bottom shelf, to which it would be screwed. Plywood forms a very good back to a carcass, for when nailed or screwed to the edges of the top rail, shelves, and in the rebate, the whole carcass is stiffened considerably.

The rebate in the bottom shelf forms a stop for the door, and if required to continue round the sides and top, may be formed by screwing on a small fillet (see section, Fig. 1).

Fig. 5 shows two methods of forming the joint between the meeting stiles of the doors. At *A*, a bead is shown worked on one stile in order to blind the joint and an equal amount of "flat" is shown on each stile. By screwing the fillet on to one stile, as at *B*, a dust-tight joint is obtained, which can be made to open and close quite easily. Here again an equal width of stile should be shown on each side, but care should be exercised in setting out, as one stile will need to be wider than the other.

The details in Fig. 6 show how a portion of a carcass for a table or desk is fitted up to take a drawer. The side rail is tenoned into the leg, and the dovetailing of the top rail holds the corner together. The remaining joints are mortised and tenoned, and either pinned or wedged as desired.

The bottom front rail is grooved to receive the tongues on the ends of the runners; this keeps both surfaces level for the drawer to run on; the runner should project a little above the rail. If a dust board is required, the runners should also be grooved and a thin board inserted as shown at *A*, Fig. 6.

The top is held down by wooden buttons as shown in Figs. 6 and 8, at the same time it is free to move should shrinkage take place. The tongued buttons will slide in the grooves, and the screws used in the rail will move in the slots provided.

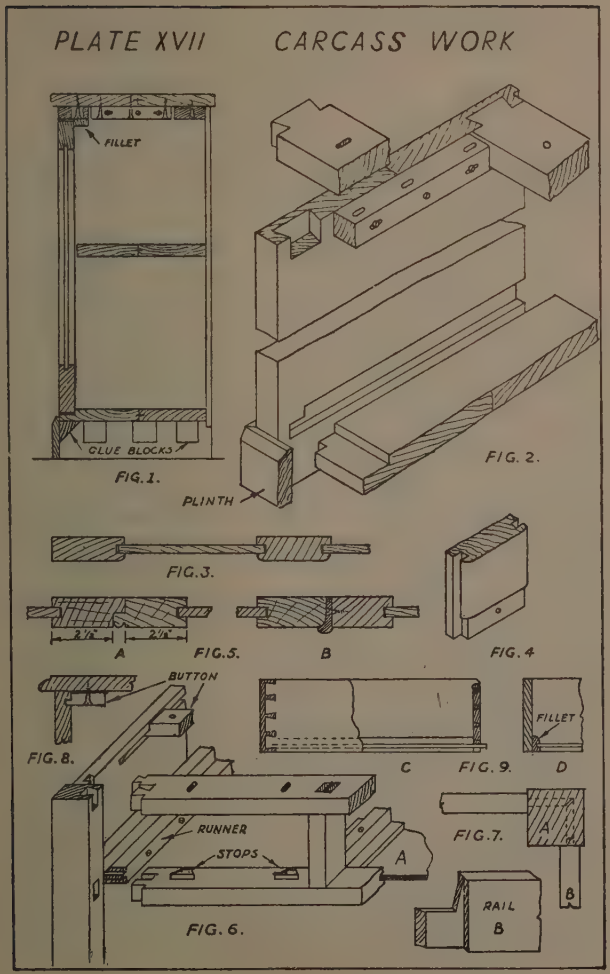


PLATE XVII CARCASS WORK
FILLET
GLUE BLOCKS
FIG. 1.
PLINTH
FIG. 2.
FIG. 3.
2⅛"
2⅛"
A
FIG. 5.
B
FIG. 4
BUTTON
FIG. 8.
C
FIG. 9.
FILLET
D
RUNNER
STOPS
A
FIG. 6.
FIG. 7.
A
B
RAIL
B

The method of jointing rails to a leg is shown in Fig. 7, in which a plan *A* is given, indicating the tenons placed as near the outside of the leg as possible in order to obtain greater length. The ends of the tenons should meet and be mitred, and the haunchion cut as shown on the end of the rail *B*, Fig. 9.

C is the side view of a drawer, showing the lap dovetail between side and front, and the end of the drawer back with the pins indicated on it.

The back is the same thickness as the sides, about $\frac{3}{8}$ in., but not as wide, as it is kept up to allow the drawer bottom to pass underneath and be nailed or screwed to its lower edge. The top edge should be kept down slightly below the top of the drawer sides.

The drawer bottom may be fitted into grooves in the sides and front or into grooved fillets which are glued on the inside of the drawer as shown at *D*, Fig. 9. As these fillets and the drawer runners have to stand up to a great deal of hard wear, they should be made from a hardwood, such as oak or birch. Oak is also suitable for drawer sides, even though the front may be some other kind of wood. When making a drawer, the front should be first carefully fitted into the opening with no allowance all round. The face and top edge should be marked for later identification, as the opening may not be quite parallel or square at the ends, and any changing round of the drawer front would then result in a badly fitting drawer. The sides and back are set out to suit the front, and the dovetailing proceeded with in a manner already explained in the chapter on joints. If these instructions are carried out, the drawer will be a tight fit and will require easing, but only sufficient should be taken off to allow a nice sliding fit. It is those extra few shavings taken off the wrong place which just make the difference between a good fit and a sloppy one. Stops made out of plywood are glued and pinned on the drawer rail as shown in Fig. 6. These are to position the drawer and prevent it being pushed too far into the opening.

CHAPTER VII

DOORS

Door Frames and Casings (Plate XVIII)

FIG. 1, Plate XVIII, shows a typical section of a piece of 4-in. by 2½-in. door framing rebated and ovolo moulded, also the position occupied by the mortise and tenon when jointing the jamb to the head. This joint is shown in pictorial view in Fig. 2, where the scribing of the moulding may be clearly seen. The head is left about 4 in. longer each end for building into the brickwork, these extra portions being known as horns. They allow the tenon to be kept to the full width, and provide added strength when the tenon is being wedged up. If they are to be cut off afterwards, the tenon should be reduced in width and haunched.

The iron dowel is let into a hole in the stone step and grouted in with cement; this provides a firm fixing for the lower end of the frame. The jambs are nailed to wood pads which have previously been built into the brickwork joints. Alternate methods of fixing and finishing are shown in the horizontal sections (Figs. 3 and 4). In Fig. 3 the frame is placed near the outside of the wall for the door to open outwards, the inner part of the wall covered with a lining board and architrave, which are nailed to the rough-wood ground, this being fastened to the wood pads. The outer joint is made weatherproof by pointing with mastic and bedding a quarter-round fillet which is nailed to the frame.

In Fig. 4 the frame is fixed in a rebate on the inside of the wall and arranged so that the door is allowed to open inwards.

Owing to the variation in sizes, a making-out fillet is required to come flush with the face of the plaster and to provide a fixing for the architrave which, incidentally, covers the joint between plaster and fillet.

Door casings or linings are used for internal door openings,

PLATE XVIII. DOOR FRAMES & CASINGS

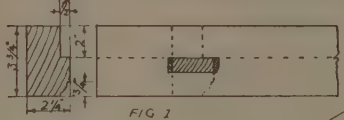


FIG 1

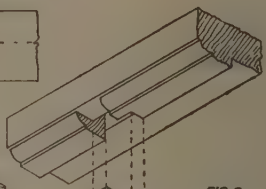
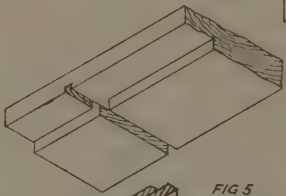


FIG 2
JOINT AT HEAD OF DOOR FRAME



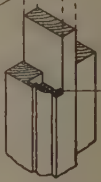
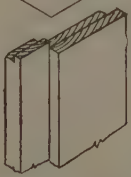


FIG 5
TONGUED JOINT AT HEAD OF CASING



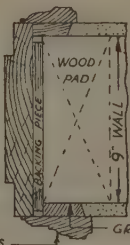


FIG 8
DOUBLE REBATED CASING

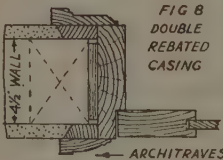


FIG 7
6"×1⅛" SINGLE REBATED CASING

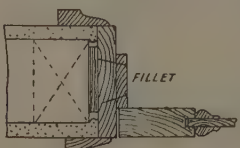


FIG 6

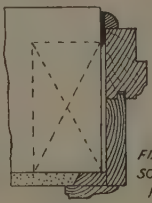


FIG 3

FIXING OF SOLID DOOR FRAMES

FIG 4

and should be at least 1½ in. thick, so that after the ½-in. rebate is taken out, sufficient thickness is left for screwing on the hinges. The jambs are tongued into the head as shown in Fig. 5, this being the best type of joint, as the tongues help to prevent the jamb from warping and showing an open joint.

Fig. 7 is a section through the jamb of a single rebated casing in a 4½-in. wall showing the rough-wood grounds and architraves which, with the casing, are nailed to pads or plugs fixed in the brickwork joints. Packing strips, known as backing pieces, are inserted between the casing and the wall to fill up the intervening space and to make the casing solid for nailing. When wide casings are used as in Fig. 8, it is advisable to double rebate them as shown. This arrangement will give the casing a more balanced appearance and reduce the amount of wide flat surface which is showing.

Linings for walls more than 9 in. thick should be built or framed up like panelling in order to reduce the risk of shrinkage which would be noticeable in one wide board.

The casing shown in Fig. 6 is of a poorer quality, because it is formed with a 6-in. by 1-in. square-edged board which has a ½-inch fillet nailed on to form a stop for the door.

When assembling casings and frames, a batten should be cut to the correct width and nailed in the rebate about 6 in. up from the bottom of the jambs. The head is then squared and another batten about 2 ft. long is cut and nailed into the rebates, diagonally across the corner. These battens help to keep the frame rigid until it is fixed.

Types of Doors (Plate XIX)

Those doors shown in Plate XIX do not cover the whole range, but they illustrate a few of the standard types and are given here to point out the names and sizes of the members to enable the learner to compare the designs.

There are many stock-pattern doors which can be bought ready made, but there are times when a door is required

which is not a stock pattern or size, and it must then be specially made. An effort is made to maintain a standard set of sizes for doors in order to keep them in proportion, this proportion being determined by adding 4 ft. on to the width in order to find the height, which means that an ordinary standard door 2 ft. 6 in. wide will be 6 ft. 6 in. high. This ruling is not always adhered to, as it is sometimes necessary to alter the height or width of a door for certain reasons. The ledged and braced door (Fig. 1) is a cheap type of door, and is used in situations such as outbuildings. The flat boarded face permits the rain to run quickly off and not lodge as it would do on the rails of a panelled door. The tongued and grooved boards are nailed to the three ledges, with the nails long enough to protrude ½ in. through the ledges, so that they may be clinched over and punched below the surface. The two outside boards should be screwed on for additional strength, and the braces fixed as shown, leading upwards from the hinge side. These braces are put on to prevent the door from drooping or sagging when in use. When assembling, all hidden parts, such as the edges of the boards and the backs of the ledges, should be painted to protect the wood and prevent rot, and if the door is fully exposed, the top edges of the ledges should be bevelled to throw off the water.

The framed ledged and braced door (Fig. 2) is stronger and of better quality than the ledged and braced door, but it is used in similar positions to that already mentioned. The stiles and rails are framed together and the space filled in with tongued and grooved boards, these doors being sometimes called " framed and filled."

The stiles and top rail are the full thickness of the door, and are grooved to receive the tongues on the boards, a variation of this being a rebate in the stiles and top rail to take the full thickness of the boards. The middle and bottom rails are really ledges, as they are reduced in thickness to allow the boards to pass over and be nailed to the face of each. This arrangement causes the tenons on the

PLATE XIX. TYPES OF DOORS

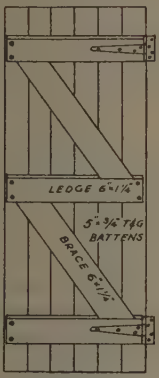


FIG 1 LEDGED AND BRACED

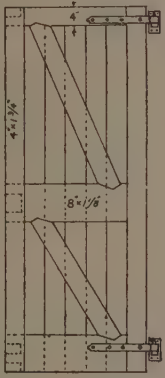


FIG 2 FRAMED LEDGED AND BRACED

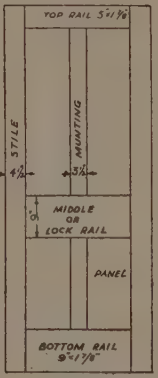


FIG 3 FOUR PANELLED DOOR

FIG 4 FOUR PANELLED WITH HIGH LOCK RAIL

FIG 5 SIX PANELLED

FIG 6 DIMINISHED STILE SASH DOOR

ends of these ledges to be bare-faced tenons, that is, they are shouldered on one side only, as shown in Fig. 5, Plate X.

The braces should be cut into the rails as shown, and not fitted from corner to corner of the panel, as any pressure exerted on the braces does not tend to force open the joints, as would otherwise be the case.

Panelled doors are named according to the number of panels, and are used as internal doors, their size depending on the position they are to occupy. Their appearance depends on the disposition of the panels, as will be seen by comparing the two four-panelled doors (Figs. 3 and 4). In Fig. 3 the lock rail has been placed low down, a suitable height being about 2 ft. 9 in. from the floor to the centre of the rail.

The position of the lock rail, as shown in Fig. 4, has been determined by the top panel, which has been made square, this being considered better in appearance than if the panel were made nearly square. This is a matter of design, and is illustrated in Fig. 5, where a frieze rail has been introduced forming two square panels known as frieze panels.

A few sizes for the stiles, rails, and muntings have been indicated in Plate XIX, and it will be noticed that these vary in width. The middle and bottom rails are usually made wide, as much for strength as for appearance. The lower half of a door should appear to be heavier than the top half, and top rails may be made slightly wider than the stiles, for if they were the same width, their position being above the eye-level would cause them to appear narrower than the stiles.

Muntings should be kept narrower than the rest of the framing, so that they do not occupy too much of the panel space and cause the framing to look cumbersome.

Sash doors are those which are glazed, sometimes for the full height or only the upper half, as in Fig. 6. They are used in interior positions where extra light is required, such as vestibule doors to a hall, or along badly lit passages, where the borrowed light through these glazed doors is very

useful. The upper portion of each stile is reduced in width in order to increase the area of glass and incidentally the amount of light. This cutting away of the stiles gives the door its name " gun-stock stile " or " diminished stile " door.

The glazed part of the door is moulded and rebated in a similar manner to a sash, and the glass used should be fairly heavy, bedded in the rebate with strips of wash-leather and held in position by moulded wood strips screwed into the rebate with brass screws. When a door is slammed, the wash-leather strips take the shock and prevent the glass being broken.

Panelling (Plate XX)

When discussing the panelled doors as shown in Plate XIX, no mention was made concerning the panels and mouldings, as these can come under the heading of panelling generally. There are many varieties of panelling, each named according to its own particular type, and those shown in Plate XX will give a general idea of the types mostly in use.

The framing is usually grooved to a slightly greater depth than the thickness of the panel, and the panels should be left slightly less in length and width, for a panel which is too big will prevent the joints of the framing from being cramped up properly. When fitting panels, a piece of wood with a groove similar to that in the framing is used to test the edges of each panel to see that they fit correctly; this is known as " mulleting."

Fig. 4 shows a very simple form of panelling where the edges of the framing are left square and the panel flat, hence the name " square and flat." An improvement on this is shown in Fig. 5, where loose mouldings have been fitted round both sides of the panel, this would be known as twice moulded. The mouldings are mitred together at the corners of the panel and nailed as indicated into the framing; on no account should mouldings be nailed into the panels, for when shrinkage takes place, the panel is not free to move

and will therefore split. The edge of the moulding should be slightly bevelled as shown to enable it to bed down firmly into the angle between panel and framing when nailed.

Planted mouldings of this description should be kept slightly below the surface of the framing. Fig. 6 shows a section of framing which has been moulded in the solid, that is, the mouldings have been worked or " stuck " on the edge of the framing. It is usual for the width of these mouldings to be the same as the depth of the groove. When a panel is increased in thickness, so that it is flush with the face of the framing on one side, it is known as a raised panel. Examples of these are shown in Figs. 3, 7, and 8, that shown in Fig. 3 being chamfered all round.

If the panel is square, the chamfers will meet in a central point, as the width of the chamfer should be constant all round.

When the chamfer or moulding round the edges of the panel is kept narrow, the flat portion in the centre is known as the fielding, and if the edges of this fielded portion are moulded as shown in Fig. 8, the term " sunk and moulded " is then used. The type of moulding used with these panels is known as Bolection moulding. It is rebated over the edge of the framing and raised above the general surface to give it a heavier appearance, which is in keeping with the type of panel used. Accommodation is made on the panel for this moulding by leaving a flat portion of the correct width which is known as a seating (see Fig. 7).

Two forms of raised or thickened panel are shown in Figs. 1 and 2, but in these cases the edges of the panels are finished off with a bead as shown, which in Fig. 1 is worked on the vertical edges and butts against the rails at each end, hence the term "bead butt."

In Fig. 2 the bead is required to show on all four edges of the panel, and as a bead could not be worked across the end grain, a rebate is formed at each end of the panel. The vertical beads are mitred at each end, and a loose bead is glued and pinned in place. Although both types are known

PLATE XX. PANELLING

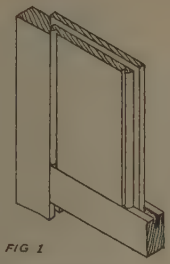


FIG 1
BEAD BUTT

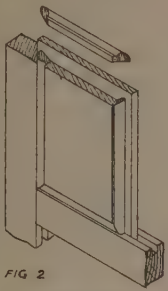


FIG 2
BEAD FLUSH

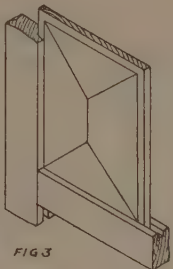


FIG 3
RAISED & CHAMFERED

FIG 4
SQUARE & FLAT

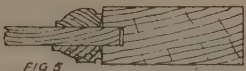


FIG 5
SUNK OR PLANTED MOULDING

FIG 6
STUCK MOULDINGS

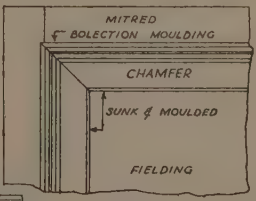


FIG 9

FIG 7
BOLECTION MOULDED

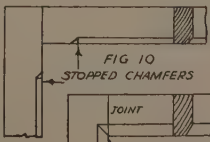


FIG 10
STOPPED CHAMFERS

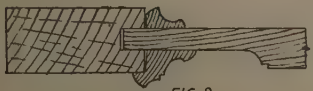


FIG 8
RAISED & FIELDED PANEL

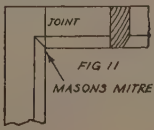


FIG 11
MASONS MITRE

as flush panels, the face of these panels should be kept slightly below the face of the framing.

Figs. 10 and 11 show the chamfer used as a finish to the edge of framing, that shown in Fig. 10 being the simplest form of stopped chamfer; other more elaborate forms of carved stops may be used if desired. If the chamfer is carried through to the joint, allowance must be made by setting in the shoulder line and mitring or scribing the chamfers, or by using the " mason's mitre " as shown in Fig. 11, with the joint in line with the edge of the stile and the mitre formed in the solid with the chamfer returned to meet that on the rail.

CHAPTER VIII

WINDOWS

A WINDOW is usually made up of a frame which contains one or more lighter frames known as sashes. It is these sashes which are glazed and fixed in the window frame or made to open for ventilation purposes, the method of opening being dependent on the type of window.

In a casement window some of the sashes are hinged to the frame, are made to open in a similar manner to a door, and are termed casement sashes. When the sashes are suspended on cords and balance weights, and slide vertically in a frame, this is known as a cased or boxed frame window and sometimes as a sash and frame window.

Sashes may also be made to slide horizontally in a solid frame without any cords or weights, this window is then known as a Yorkshire light.

Another type is the pivoted sash, where the opening is effected by the sash pivoting on metal pins either about a horizontal or vertical axis.

The timber used for window frames is usually red pine, but in good-class work, where precautions are taken against rot, the sill should be made of teak or oak.

These windows will now be discussed in further detail, the first one being the casement window in Plate XXI. The one illustrated is a four-light window with the sashes opening outwards; the lower sashes are side hung, and the top or transome lights hung at the top. The frame is composed of two jambs, which are tenoned into a head and sill; a horizontal member, called a transome, is tenoned into the jambs, and runs right through, thus dividing the vertical mullion into two pieces which are tenoned at the ends. The framing is rebated to a depth of $\frac{1}{2}$ in. to receive the sashes and grooves or throatings formed, both in the framing and on the edges of the sashes, in order to prevent water from

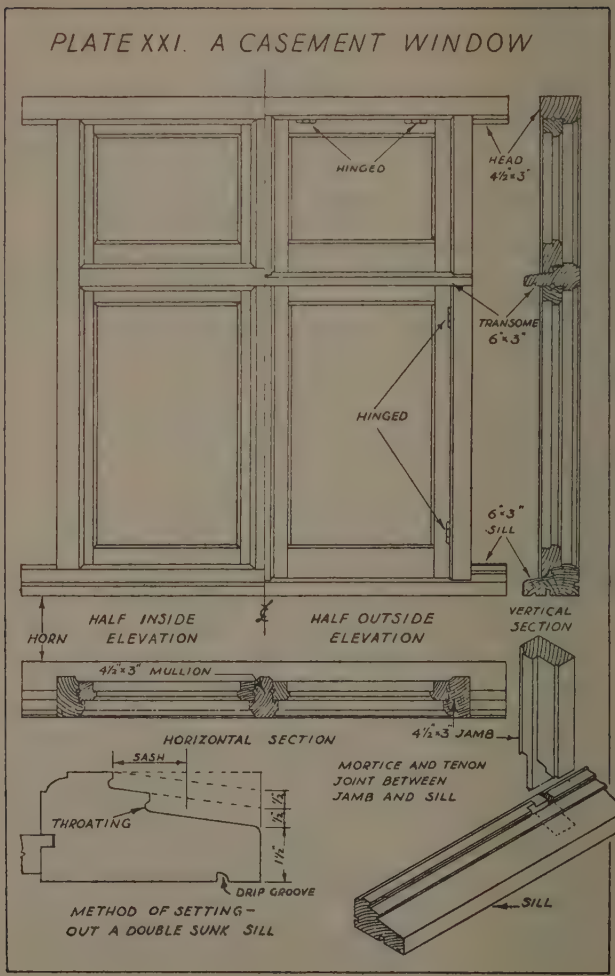


PLATE XXI. A CASEMENT WINDOW
HINGED
HEAD 4½×3"
TRANSOME 6"×3"
HINGED
6"×3" SILL
HALF INSIDE ELEVATION
HALF OUTSIDE ELEVATION
HORN
VERTICAL SECTION
4½"×3" MULLION
4½"×3" JAMB
HORIZONTAL SECTION
SASH
THROATING
1½"
DRIP GROOVE
MORTICE AND TENON JOINT BETWEEN JAMB AND SILL
SILL
METHOD OF SETTING-OUT A DOUBLE SUNK SILL

creeping through the joint. One of the most vulnerable places in a casement window is the joint between the sash and sill or transome. To prevent water driving in, the top surface of these two members is bevelled off or weathered, and one or two sinkings formed as shown in the detail. On the underside a drip groove is formed to check any water which is likely to find its way into the joint.

At each end of the sill and head, an extra length of 3 in. or 4 in. is left on for building into the wall as work proceeds; this is known as a " horn," and very often wrongly termed a " joggle."

If a frame is to be fixed into a prepared opening and the horns cut off flush with the jambs, the tenon should be reduced in width and haunched on the outside to allow for wedging. These frames are fixed in a similar manner to door frames, i.e. by nailing into wood pads or plugs which are fastened in the brickwork joints.

Timber for window and door frames, known as "framing," may be bought ready rebated and moulded to stock section and pattern, the sizes varying slightly from 4 in. by 2½ in. to 4½ in. by 3 in. for jambs, heads, and mullions, whilst sills and transomes may be cut out of 4-in. by 3-in., 6-in. by 3-in. or 7-in. by 3½-in. material.

The Cased or Boxed Frame Window (Plate XXII)

This type of window is not used so extensively, because it has been superseded by the casement type of window. The real reason for this is the production cost and the cost of maintenance, mostly due to the renewal of the cords on which the sashes are hung. From all other aspects the cased or box frame is a better type of window because good ventilation may be obtained without a direct draught, and the weather-proofing is superior.

The frame of this type of window is built up of fairly thin pieces except the sill, which is solid. The reason for this is to form a box jamb, in which the balance weights may be housed and free to move up and down when the sashes are

operated. Fig. 2 is a section through a jamb showing the various members.

The pulley stile, into which the pulleys are fixed, and the head or soffit lining, are made thicker than the inner and outer linings, the thickness varying from 1 in. to 1¼ in. The inside and outside linings may be ¾ in.–1 in. thick, and grooved as shown to take the tongues on the pulley stile; the back lining is made of thin rough pieces wide enough to nail on the edges of the linings.

The sill is trenched to take the ends of the pulley stiles, this trenching being slightly lower than the weathering at the outside and wide enough to allow the pulley stile to be driven in tightly and nailed from the back. An alternative method is to allow room in the trenching for a wedge to be driven in at the back of the stile and nailed to the sill.

The top ends of the pulley stiles may be housed or tongued into the head lining and further secured by nailing, as shown in Fig. 4. Glue blocks are used along the inside angles of the head in order to stiffen the linings, which have no back lining to depend on as at the jambs. The top end of the parting slip, also the method of supporting it, are shown in Fig. 4.

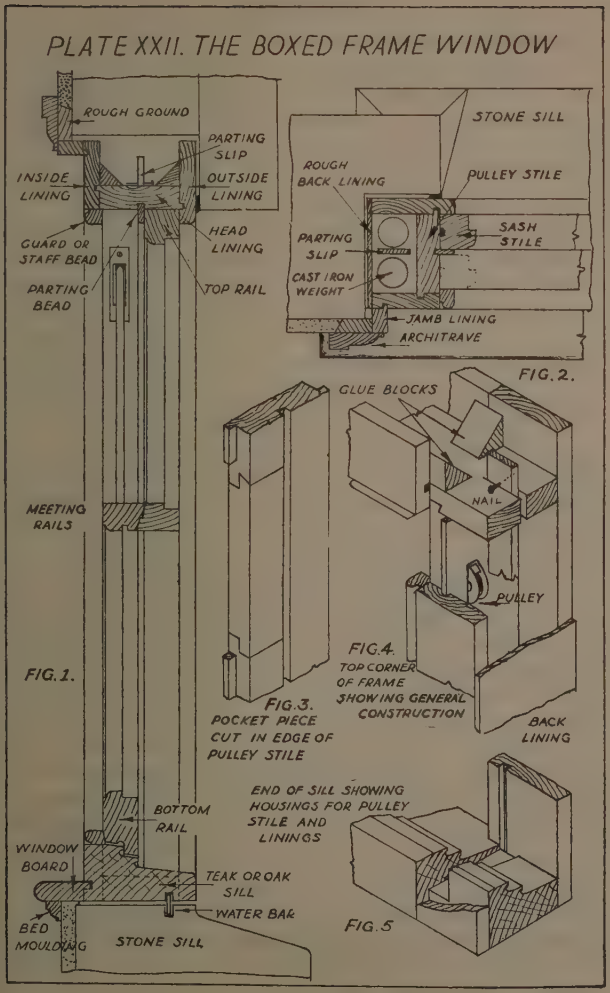
This slip is a piece about 1½ in. by ¼ in., which hangs loosely from the head lining, its purpose being to separate the weights and prevent the cords from fouling each other.

The slip should have plenty of side play to facilitate the removal of the weights when renewing cords.

The linings are nailed to the edges of the pulley stiles, head, and sill, provision being made at the ends of the sill as shown in Fig. 5. A pocket is provided in each pulley stile, through which the weights may be withdrawn. The size of the pocket varies according to the size of the window and the weights, but generally speaking the length may be slightly less than that of the weights, and the width about ¼ in. more than their diameter. The pocket is situated near the bottom of the pulley stile, and may be cut from the centre or from the inside edge.

The centre pocket is more costly, because a new piece must

PLATE XXII. THE BOXED FRAME WINDOW



be fitted, but if it is cut from the edge, as shown in Fig. 3, the original piece may be used.

To cut out this pocket, bore two holes from the back of the lining into the groove for the parting bead, the centres for these holes being where the joint lines cross the centre of the groove. This arrangement will enable a fine saw to be used for the joints and for a cut down the centre of the parting bead groove.

A slight tap with a hammer on the back of the pocket and near the lower end will cause the grain at the joints to split and free the pocket piece. This piece need not be screwed or nailed when in position, because it is held by the parting bead and the guard bead, and will not cause any obstruction to the sash. A portion of the tongue must be removed from the edge of the pulley stile as shown in Fig. 3, and when assembling the frame care must be taken to ensure that the lining is not nailed to the pocket piece.

When fixing pulleys, the top of the plate should be kept about 2 in. below the head lining and the mortises made to fit the pulley case tightly.

When the material has been prepared, the sill pulley stiles and head lining are assembled and nailed. This frame is then squared by testing the diagonals with a staff, the frame being adjusted until these lengths are equal. The frame is then fixed in this position on the bench, and the linings nailed on and all trimmed and cleaned up. A parting bead is fitting between the grooves and tapped into the groove in the head lining; the two vertical beads are scribed to fit this and cut slightly tight in the length. The bead is bent by pulling outwards from the pulley stile, while the two ends are fixed in position; it is then sprung into place and tapped home in the groove, into which it should fit tightly because it is not nailed. The guard beads are mitred at the corners, the short lengths being fitted first and the long ones sprung into position and nailed. These beads should not be nailed too near the ends, as difficulty will be experienced when they are being removed for cording.

The correct balance weights may be ascertained by weighing a sash after it has been glazed and painted. In the case of a top sash, each weight should be equal to a little more than half the weight of the sash, thus tending to keep the sash closed at the top. The bottom sash should be slightly heavier than its two weights in order that it may close easily. The length of the cords should be such that the weights of the top sash are kept about 3 in. clear of the sill when the sash is closed, and those of the bottom sash should allow the weights to be just clear of the pulleys when the sash is down.

Sash cords may be hemp or cotton, steel wire, stranded copper wire or chains.

When cording windows, a small lead weight known as a " mouse " is attached to a length of fine cord, this being tied to the sash cord. The mouse and its tail are fed through the pulley and pulled through the pocket, the sash cord following. One end of the sash cord is attached to the weight (usually by threading through an eyelet and knotting) and the other end is nailed into a groove which extends about 12 in. or 15 in. down the edge of the sash. This fixing should be kept clear of the top of the sash, or it will foul the pulleys when the sash is raised to the top of the frame.

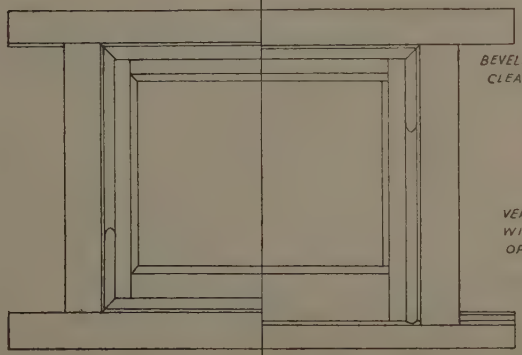
Very little clearance is needed for the sashes in the frame, $\frac{1}{16}$ in. all round being a maximum before painting ; excessive clearance can be more troublesome than a tight fit.

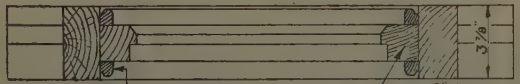
The Pivot Hung Sash Window (Plate XXIII)

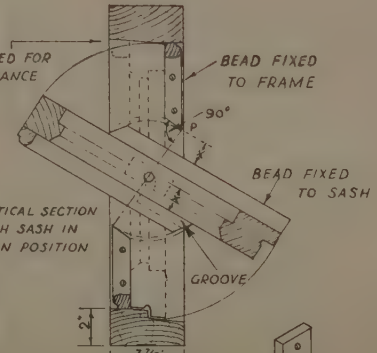
Part elevations and a horizontal and vertical section of this window are shown in Plate XXIII. The frame is solid, and beads are attached to form a rebate or housing for the sash, which is fixed on pivots near its centre.

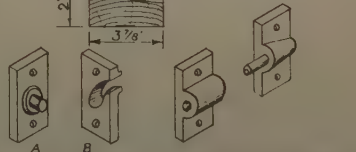
As it is quite obvious the beads cannot be fastened entirely to the frame, provision must be made for opening the sash to its maximum open position, which may be nearly horizontal. The beads are cut with a splayed cut, which is often a 45° angle, one portion of the bead being fastened to

PLATE XXIII. A PIVOT HUNG SASH WINDOW









the frame and the other portion to the sash. This enables the sash to open freely, and when closed the beads will appear to run unbroken round the frame.

A method of determining these cuts is shown in the vertical section. The lines of the sash and beads are drawn in the open position, and an allowance of about 1 in. made at *X*, thus fixing a point on the outer bead as at *P*. A line is then drawn from *P* through the centre of the pivot, and the bevel cuts marked off at right angles from the ends of line. This bevel gives the minimum amount of clearance necessary for the ends of the beads, and the lengths of the beads may be measured from the drawing. The clearance shown at *X* is to enable the sash to be lifted off the pivots and removed from the frame without having to take off any beads. The amount of clearance is dependent on the size and type of pivot. *A* has been fixed to the frame and the socket *B* on the edge of the sash, with a groove formed in the edge of the sash and the bead to accommodate the pin when the sash is taken in or out of the frame.

If the pivot is fixed to the sash and the socket on the frame a groove must be formed in the frame in order to enter the pin of the pivot plate when fitting the sash. In this instance very little clearance is required in order to remove the sash, and the cuts for the beads may be set out accordingly. Pivots should be fixed slightly above the centre point in order to upset the balance and cause the sash to have a tendency to keep closed, due to the extra weight of the lower half. The pivots shown at *A* and *B* are used when the sash is in the centre of the frame, but in order to use the face fixing pivots, the inside faces of the sash and frame must be flush.

As these windows are used for ventilation purposes more than for lighting, they are often situated near the top of a room and out of reach, therefore some means of opening and closing should be provided. A cord is used for this purpose, one end being fastened to an eyelet on the bottom rail of the sash and the other end to the operating lever of a

spring catch which is fixed to the top rail. The sash is k
open by securing the cord to a hook or cleat fastened on
wall.

Interior sashes in screens, etc., are often made to o
vertically by fixing the pivots to the top and bottom ra

Skylights (Plate XXIV)

Skylights may be fixed roof lights or hinged frames,
the chief concern is to so construct the fitting that i
watertight. Fig. 1 shows a section through a hinged s
light and the curbing to which it is hinged. In this case
roof timbers have been framed and trimmed to form
opening of the required size, and the curb lining fitted ro
the four sides of this opening. The lining should be w
enough to stand at least 4 in. above the roof in order tha
lead-lined gutter may be formed at the back and sides of
skylight.

Alternative methods of forming the side gutters are sho
in Fig. 2. That shown at *B* has the advantage of
additional 5-in. by 2-in. curb, which allows a thinner lin
to be used round the inside. The top edge of this curb r
be tongued to fit a groove in the underside of the skyli
frame, thus affording a very good wind and rain che
Another method of forming a check is to fix a small f
round the under edge of the frame as shown. Also a c
groove is very useful in preventing water from creep
into the joint.

Although the frame is similar to a sash, there are cert
differences, which are shown in the details. The framin
wider so as to accommodate the various fillets, grooves
mouldings. The stiles and bars are rebated for the gl
but the top rail should be grooved, as this is rathe
vulnerable spot.

The bottom rail is reduced in thickness to enable the g
to extend half-way across the top face, and incidentally
allow the water to run off. The glass may continue acr
the full width of the rail ; but unless it is kept clear

PLATE XXIV. SKYLIGHTS

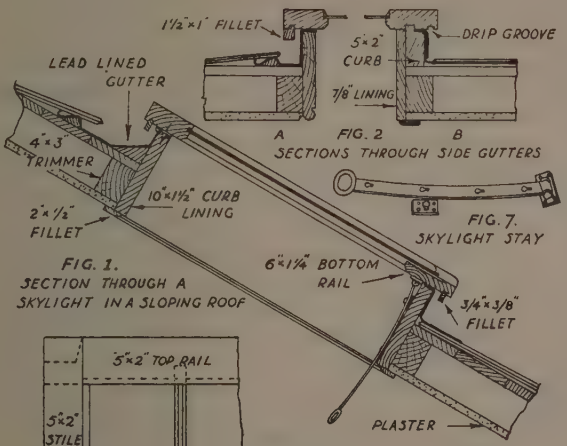


FIG. 1.
SECTION THROUGH A SKYLIGHT IN A SLOPING ROOF

FIG. 2
SECTIONS THROUGH SIDE GUTTERS

FIG. 7.
SKYLIGHT STAY

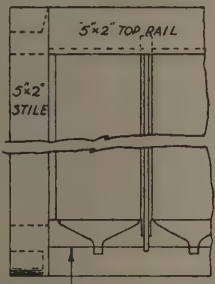


FIG. 3.
PART PLAN

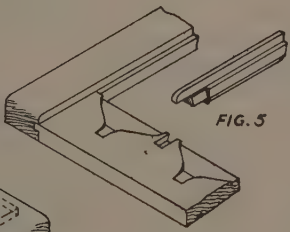


FIG. 5

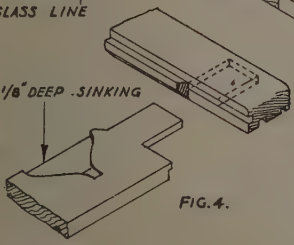


FIG. 4.

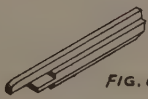


FIG. 6

the top surface, there breakages may occur due to pressure caused by the rail material warping. There is also the added danger of water creeping up between the glass and the rail due to capillary action. To offset this, a sinking should be made in the rail as shown in Fig. 4. Any condensation moisture which may collect on the underside of the glass will run into this sinking and pass out through the small outlet.

The bottom rail should be made wide enough to provide fixing room for a suitable type of skylight stay such as that shown in Fig. 7. The joints at the corners of the frame are mortised and tenoned as shown by the dotted lines in Fig. 3 and the detail of one end of the bottom rail, Fig. 4. The lower ends of glazing bars should be carefully jointed because there is little thickness in which to do this.

The small tenon joint may be used as shown in Fig. 6, or the dovetailed joint shown in Fig. 5, providing the bar is prevented from lifting. Should the skylight be raised by pushing on the glazing bar and not the metal stay, the joint being a weak one, the bar may be lifted clear of the rail with disastrous results.

Skylights should be kept in good repair and well painted and puttied, otherwise they become a constant source of trouble due to leakage.

Sashes

A sash is a light frame composed of two vertical stiles and a top and bottom rail, and it is this frame which carries the glass in a window. In the case of a fixed light, viz. a sash which does not open for ventilation, in a casement window, the sash is sometimes dispensed with and the glass fixed direct into the rebate of the frame. The fillets known as " glazing beads " which hold the glass in place are about $\frac{1}{2}$ in. thick, and when used in place of a sash give an unbalanced appearance; therefore, this form of glazing is not to be recommended.

The corners of a sash are mortised and tenoned, wedged,

and pinned, this extra precaution of pinning being taken on account of the smallness of the joint, which can so easily be loosened by rough usage. When the sash has been cramped up and the joints wedged, a $\frac{5}{16}$ in. hole is bored through the stile and tenon close to the shoulders of each joint. The pins which are driven into these holes are made square in section in order to ensure a tight fit.

When assembling the joints, thick paint or waterproof glue should be used, as these joints are exposed to damp conditions. The thickness of sashes varies from $1\frac{1}{2}$ in. to $2\frac{1}{4}$ in. with the width of the stiles and top rails in proportion, a common section being $1\frac{3}{4}$ in. by $1\frac{3}{4}$ in. The bottom rail should be made wider than the other members, the width being equal to about twice the thickness. This is done to strengthen the joints at the bottom of the sash and to allow for the bevelling of the rail where it fits the weathering of the sill.

If a sash is required to be divided into a number of small panes instead of one large sheet, then glazing or sash bars are introduced. The width of these bars is equal to the thickness of the sash and the thickness out of 1-in. or $1\frac{1}{4}$-in. stuff. Sash framing should have the rebate $\frac{3}{8}$ in. deep if possible, and not less than $\frac{3}{4}$ in. wide, with the moulding the same depth as the rebate to bring the shoulders opposite, thus facilitating the setting out and making of the joints. Glazing bars are double rebated and moulded as shown in Fig. 4, Plate XXVI. These mouldings, in varying sizes, are in common use for framing generally, and are known as: (*a*) chamfered, (*b*) ovolo moulded, and (*c*) lamb's-tongue moulded.

Meeting rails for double-hung sliding sashes are slightly different in section to the remainder of the sash members, as will be seen in the vertical section, Plate XXII. They should be $\frac{3}{8}$ in. wider than the thickness of the sash, to make up for the gap caused between the sashes by the parting beads, also to enable the bevelled joint to be made between the two rails. The meeting rail of the top sash does not require any

moulding on the top edge, and the rail of the bottom sash has only a groove for the glass instead of a rebate, which would be difficult to putty with the sashes in position.

Details of sash joints are given in Plate XXV, Figs. 1 and 2, illustrating the usual type of mortise and tenon joint for sashes. Different mouldings are shown in order to illustrate the two methods of dealing with the joints. When the end of a rail is shaped to fit a moulding on the stile, it is known as scribing, and in the case of the chamfer in Fig. 1, the scribing when worked by hand may be quite easily carried through the full width of the rail, as is the practice when scribing for mouldings in machined work. Other mouldings, such as the ovolo or lamb's-tongue, when being dealt with by hand, are better scribed as shown in Fig. 2, that is, a portion of the moulding is removed from the stile, leaving just sufficient to be covered by a short length of scribing on the rail.

The square portion left on the bottom of the stile fits into the housing on the end of the rail ; this method is known as " franking," and although it is the reverse of haunching, it serves the same purpose, i.e. to keep the faces of the rail and stile in the same plane by preventing movement of the rail where there is no tenon.

Tenons need not be wider than half the width of the rail; they will do their job just as well as a wide tenon, as more wood is left between the wedge and the end of the stile, and there is less danger of the part bursting out when the joint is wedged up. It is a common fault making tenons too wide, and nothing is gained in so doing. Further details are shown in Plate XXV, which illustrates the joints between meeting rails and stiles of double-hung sashes. As the meeting rails are only $1\frac{1}{4}$ in. or $1\frac{1}{2}$ in. in thickness, there is not sufficient room for a wedged tenon, therefore the dovetail is used to increase the strength of the joint. As with the tenon, the dovetail is arranged to come in the square portion of the stile, and the joint edge of the meeting rail is housed into the stile for additional strength, a portion of this

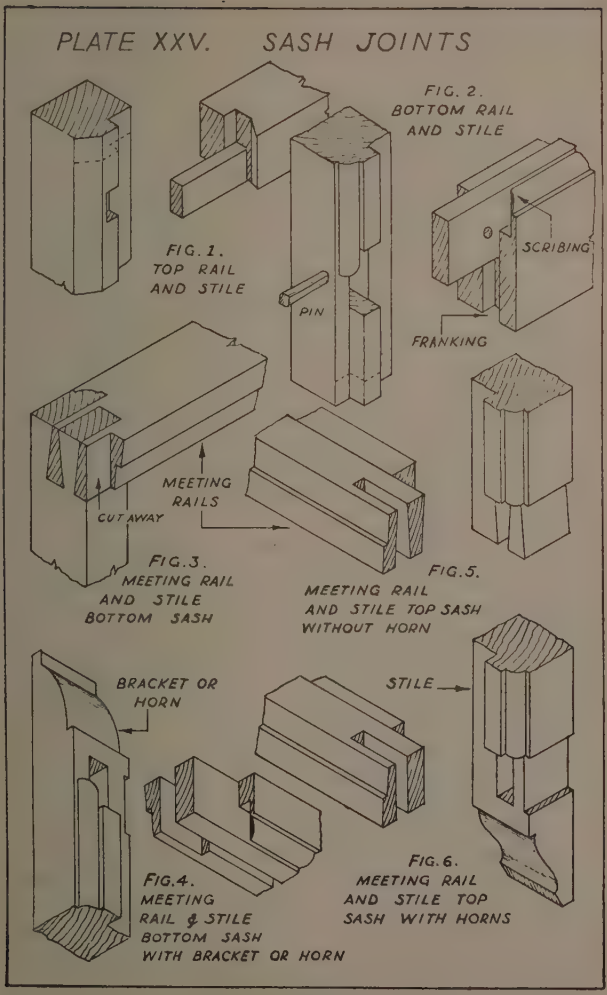


PLATE XXV. SASH JOINTS
FIG. 1. TOP RAIL AND STILE
PIN
FIG. 2. BOTTOM RAIL AND STILE
SCRIBING
FRANKING
MEETING RAILS
CUT AWAY
FIG. 3. MEETING RAIL AND STILE BOTTOM SASH
FIG. 5. MEETING RAIL AND STILE TOP SASH WITHOUT HORN
BRACKET OR HORN
FIG. 4. MEETING RAIL & STILE BOTTOM SASH WITH BRACKET OR HORN
STILE
FIG. 6. MEETING RAIL AND STILE TOP SASH WITH HORNS

bevelled edge being cut away to clear the parting bead as shown in Fig. 3. The ends of the stiles at the meeting rails are sometimes left 3 or 4 in. longer and shaped to form a bracket or horn. This arrangement forms an additional guide for the sash, and allows the ordinary mortise and tenon joint to be used. Details are shown in Figs. 4 and 6, with suggestions for moulded horns.

Methods of jointing sash bars are shown in Plate XXVI. The joint shown in Fig. 1 should be made by hand, because it would be very difficult to execute it by machine. It is fairly easy to make and has one advantage : both vertical and horizontal bars are kept in complete lengths and not cut up into small pieces as with the mortise and tenon joint as shown in Fig. 2, which may be made by hand or machine. A variation of the joint is shown in Fig. 3. In this example the tenons are left longer, but reduced in thickness, so that they overlap. This is a stronger joint but more costly to make. If a sash is divided into a number of small panes, great care should be taken with the setting out in order to avoid a wavy appearance in the bars when assembled. In casement sashes the horizontal bars should be left in one length to assist the rails by preventing the sash from sagging, while in vertical sliding sashes the vertical bars are complete lengths tenoned at each end, and they help to strengthen the meeting rails. The hook joint shown in Fig. 5 is a very useful joint to employ where two stiles meet, as in a casement window without a mullion it makes a close-fitting weathertight joint. Fig. 6 is a simple type of window not now in great demand, but still very useful, as the principle may be used in all forms of horizontal sliding sashes or doors. The frame is solid and the sashes are kept in position by beads. One or both sashes may be made to slide on hardwood strips which are fixed in the sill and the meeting stiles in the centre are rebated to keep out the weather (see horizontal section).

Fig. 7 is a section through the head and sill of a wood frame prepared to receive a metal frame.

PLATE XXVI. WINDOW DETAILS

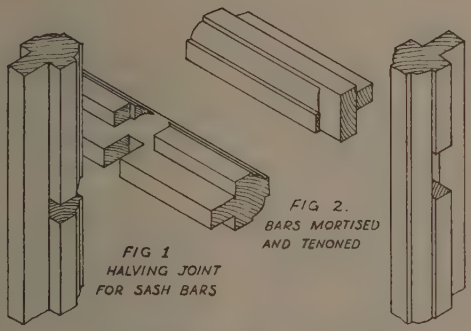


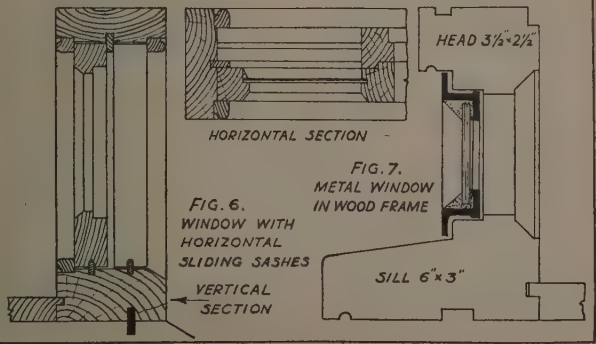
FIG 1
HALVING JOINT
FOR SASH BARS

FIG 2.
BARS MORTISED
AND TENONED

FIG. 3.

FIG. 4.

FIG. 5. HOOK JOINT



CHAPTER IX

STAIRS

THE various types of stairs may be named according to the shape of the plan or the construction of the string, and they are roughly divided into two classes : newel and non-newel. The first-mentioned includes dog-legged, open newel, and spiral stairs, where the newel is essentially part of the construction.

The non-newel stair is one in which the outer string and handrail are continuous, and is known as a geometrical stair. Newels may be used in conjunction with this type of stair, but they are not essential in its construction and are only used for an ornamental finish to a balustrade. The shape of the plan of a geometrical stair may be rectangular, circular, elliptical, etc., and the stair is named according to its shape. The part of a building which contains the stairs is known as the " staircase," and the stair itself is made up of flights of steps and landings or resting-places.

A few examples of the foregoing stairs are shown in Plate XXVII, and the various parts are named. Each step is composed of a horizontal member called the " *tread* " and a vertical member called a " *riser*." These steps, when parallel, are termed " *fliers*," but when fitted in an angle in the form of triangular steps they are called " *winders*," the centre one being known as a " *kite winder*." The *strings* are the inclined members which are housed to take the ends of the steps, and are supported at each end by a *newel post*. The newel post also affords a fixing for the end of the handrail, and is itself supported by the landing joist or extended to the floor, as would be the case with the newel which carries the winders, as shown in Fig. 1, Plate XXVII.

The strings in newel stairs are called close-strings or housed-strings, having their top and bottom edges parallel, and being wide enough to project above the steps, and show

PLATE XXVII. STAIRS

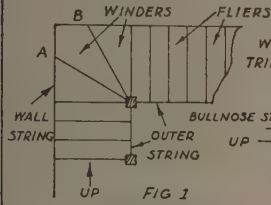


FIG. 1
WINDER STAIRS

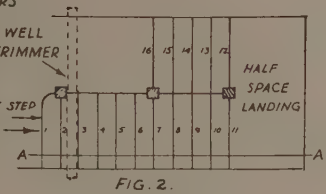


FIG. 2.
DOG-LEGGED STAIR

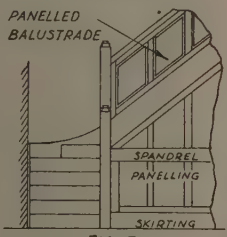


FIG. 3.
ELEVATION OF FIG. 1.

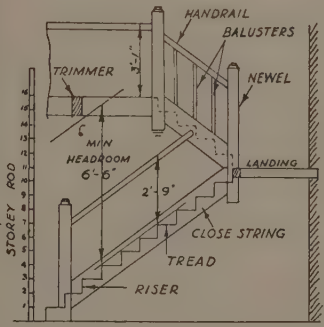


FIG. 4.
SECTIONAL ELEVATION ON A.A.

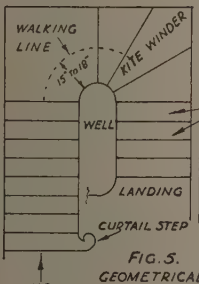


FIG. 5.
GEOMETRICAL STAIR

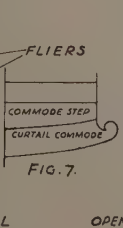


FIG. 7.

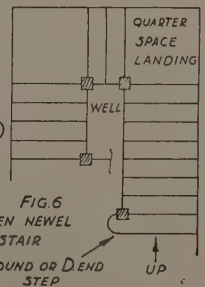


FIG. 6
OPEN NEWEL STAIR

a margin of 2–3 in. above the profile of the steps (see Fig. 4, Plate XXIX).

The string of a geometrical stair has the top edge cut to the outline of the steps, and is known as a *cut string* (see Figs. 3 and 4, Plate XXVIII).

The winder stair in Fig. 1, Plate XXVII, shows a stair which turns through one right angle and in which three winders have been introduced instead of a quarter-space landing, such as the one shown in Fig. 6. Landings are to be preferred to winders, as the latter may prove dangerous, but sometimes the use of winders is unavoidable, because of the limited amount of going space available. Under such conditions the introduction of winder steps means that two extra steps are provided in the place of a landing. The going distance is the horizontal measurement from the face of the first riser to the face of the last riser in a flight. Fig. 3 shows an elevation of a stair with the space underneath enclosed by panelling which is called spandrel panelling. The space between the string and handrail may be filled in with panelling as shown to form a close balustrading, or with balusters as shown in Fig. 4.

Fig. 2 is the plan of a dog-legged stair which turns through two right angles and contains a half-space landing extending the full width of the staircase. This type of stair is used when the width of the staircase is limited and the maximum width for each flight can only equal half the total width. This causes the upper outer string to be directly over the lower one, the end of each being fixed to a single newel at the landing.

In the elevation shown in Fig. 4, the height of the handrail and the headroom is indicated. The measurements are taken vertically from a nosing line, which touches the profile of the steps, that is, the points where the top of the tread meets the face of the riser produced. When taking these measurements from the top of a tread only one point may be used, that is, the one which is vertically in line with the face of the riser. The handrail on the landing should be at

least half a riser higher than that on the stairs. The minimum headroom of 6 ft. 6 in. as shown determines the position of the trimmer joist for the upper floor.

Fig. 6 shows the open newel stair, which is constructed with a newel at each change of direction. Owing to the increased width of the staircase, it is possible to leave a space between the outer strings which is known as a well. The width of this well is sometimes arranged to provide for extra steps between the landings as shown, but care should be taken in this respect, as it may prove a dangerous procedure to divide landings by a single step, because this step forms a trap.

The geometrical stair in Fig. 5 is shown to indicate the line of the continuous string, and because the handrail is directly above, it will also follow the same line as the string. The walking line on a step is approximately 18 in. from the end of a step. It is a line on which to set out the width of winders in order to obtain the best available width where people ascending the stair are likely to place their feet.

The lowest step of a stair usually has a rounded end, which adds to the appearance of the stair.

Three of the types of such steps are indicated in Plate XXVIII. The bullnose step is shaped to a quarter-circle, the round-ended step a semicircle, and the curtail step is made to conform to the outline of the scrolled end of the handrail.

A step which has the riser curved in plan is called a commode step, and is used as a feature at the foot of a high-class stair. Two of these commode steps are shown in Fig. 7, Plate XXVII.

In Plate XXVIII plans illustrating the bullnose, round-end, and curtail step in each case with the tread and scotia removed are given.

The construction of these steps is very similar to one another, therefore a general explanation should suffice. A solid block is first made to conform to the plan shape, taking into account the thickness of the veneer, etc. ; this block is

equal in depth to the rise, minus the combined thickness of the tread and scotia piece. It is made up of three layers glued and screwed together, with the grain of each piece arranged to run in a different direction from that of its neighbour (see sectional view, Fig. 6). This is known as "laminating," and is done to prevent any distortion of the block due to the shrinkage and warping which would occur if the block were to be cut from one solid piece of wood. The curved face should be carefully cleaned up with the plane and spokeshave, and should be free from lumps or hollows, as these defects will adversely affect the bending of the veneered riser. A portion of the end of the riser is reduced to the thickness of a veneer, the length of this being carefully measured to allow a little space for the insertion of two folding wedges to tighten up the veneer after bending. The end of the riser which enters the newel is first glued and screwed to the block. Plenty of hot glue is then applied to the block and the inside of the veneer, and the bending is carefully proceeded with until the wedges can be tightened up and the straight portion of the riser secured to the block by screws.

Before bending, the veneered portion may be steamed or soaked in water for a while so as to render the wood more supple, thereby preventing breakage when the material is bent. The scotia moulding is worked on the edge of narrow strips which are screwed to the top edge of the riser and the block. These are indicated by dotted lines in Fig. 6. The tread in turn is held to the strips and the blocks by screws from underneath.

The veneering of the curtail step is done by a slightly different process. In Fig. 7 it will be seen that the end of the string is reduced to a veneer, and the ends of the veneers are held in place by a bevelled strip of hardwood which is screwed to the block.

The string in this instance is a cut string, such as the one illustrated in Fig. 3. The portion marked *A* shows a riser mitred to the string and the string cut out to support the end

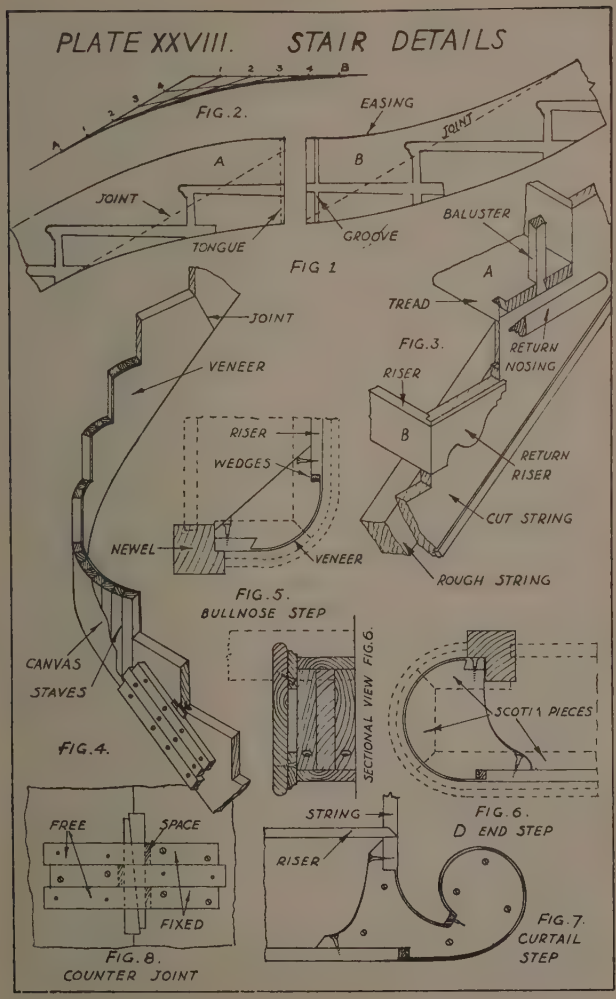


PLATE XXVIII. STAIR DETAILS
FIG. 2.
EASING
JOINT
A
B
JOINT
TONGUE
GROOVE
FIG 1
BALUSTER
A
TREAD
FIG. 3.
RETURN NOSING
RISER
B
RETURN RISER
CUT STRING
ROUGH STRING
JOINT
VENEER
RISER
WEDGES
NEWEL
VENEER
FIG. 5.
BULLNOSE STEP
CANVAS
STAVES
FIG. 4.
SECTIONAL VIEW FIG. 6.
SCOTIA PIECES
FIG. 6.
D END STEP
FREE
SPACE
FIXED
FIG. 8.
COUNTER JOINT
STRING
RISER
FIG. 7.
CURTAIL STEP

of a tread. This type of string is called a " cut and mitred " string.

The lower portion marked *B* is known as cut and bracketed, and in this example the riser is mitred to a return riser or bracket, which is a shaped piece about $\frac{3}{8}$ in. thick and nailed to the string under the end of each step.

The ends of the balusters are dovetailed into the treads, and a return nosing and scotia piece is fastened to the end of each tread to form a finish. These cut strings are usually about 1 in. thick, and do not carry the weight of the stair; this is taken by " carriages " or " rough strings," as shown in Fig. 3. The carriages are pieces of wood about 6 in. deep and 3 in. thick, and are allowed to touch the underneath corners of the steps for the full length of the flight. Carriages are supported at each end. To stiffen the treads short pieces of 1-in. thick boards, known as " rough brackets," are nailed on the sides of the centre carriage and tight up to the underside of each tread. The under edges of these carriages carry the lath-and-plaster ceiling.

Fig. 4 shows a portion of a cut string which is shaped and bent to fit round the well of a geometrical stair, as shown in Fig. 5, Plate XXVII. The shape of the face of the string, including the cutting out for the steps, is marked out and developed geometrically on a length of string board. Sufficient length is then reduced to a veneer and bent round a cylindrical drum, which is made to conform to the plan shape of the end of the well. Narrow staves are then glued to the veneered portion so as to build this up to the thickness of the solid string. Canvas is glued to the staves for additional strength. Extra-long staves are screwed to the drum at intervals so as to hold the work in position until the glue has set, when the whole may be removed and the ends of the steps fitted.

The method of cramping up the tongued joint to the straight string is shown in Fig. 8. The cleats are trenched out half their thickness to accommodate the folding wedges and then screwed to the two portions of string as shown.

When the wedges are driven home, the joint will be closed and the free ends of the cleats may then be screwed to the string and the whole left in position. This is a glued joint with a cross-tongue in a groove.

Fig. 1, Plate XXVIII, shows the setting out of the ends of the wall-strings for the winder steps, as shown in plan at *A* and *B*, Fig. 1, Plate XXVII. Owing to the extra width of the outer ends of the winder steps, the strings must be built up and shaped to a suitable curvature. With careful setting out, the waste piece which is cut from one edge of the string may be used to make out the opposite edge by glue jointing.

Fig. 2 shows a method of forming an easing from *A* to *B* by drawing intersecting tangent lines.

Setting out Stairs

When setting out stairs, the first point to consider is the number of steps required and the disposition of these steps. One of the most important rules governing this procedure is to determine the proportion of rise to tread for each step. A safe rule for correct proportion is to make twice the rise plus the tread equal 23 in., so that, having decided on a suitable rise, it is an easy matter to find the tread by doubling the rise and subtracting from 23.

Where plenty of going space is available, a step with a rise of 6 in. and a tread of 11 in. will provide a nice easy-going stair, but in cramped spaces it is sometimes necessary to use a rise of 8 in. and a tread of 8 in., giving a quotient of 24 instead of 23, which, although permissible, is not desirable as it forms a steep stair which is difficult to mount and may prove dangerous. Another rule in proportion is, multiply the rise by the tread to equal 66, but this is not so constant as the first rule, and does not compare in all cases.

Flights with more than twelve steps should be avoided, as they are tiring to mount; landings situated between flights form resting-places, and are to be preferred to winder steps. If winder steps are introduced, they should be situated at the bottom of a flight and not at the top. Be sure to make all

risers of equal height, measuring the rise from the top of one tread to the top of the next and the width of tread from face to face of the risers, ignoring any overhang or nosing to the tread, which may be added afterwards without affecting the pitch of the stair. When counting the number of steps in a flight, remember that the landing counts as a tread and that one more riser than treads will be required. Having in mind what is required for the setting out of a stair, of good proportion, the measurements may be taken from the staircase, the most important measurement being the height from the top of one floor to the top of the next. This measurement is marked on a story rod, which is a staff about 10–12 ft. long and 1½ in. square (see Fig. 4, Plate XXVII, where a story rod is shown marked out for the risers of the dog-legged stair). This total height is then divided up into a suitable number of risers by setting the compasses to what may be considered a reasonable rise, say 7 in., and then stepping this measurement along the staff, adjusting until a rise is determined which will go an exact number of times into the total height. From this will be found the number and width of the treads required by using the rules already mentioned.

The width of the treads should be checked against the total going distance available, taking into account landings, etc.

It is a good plan to make line drawings to scale similar to those shown on Plate XXVII, so that measurements and details are shown in their proper place and sufficient headroom is allowed and trimming to landings and floors may be checked over.

Next to set out the strings which may be considered the most important parts of a stair. The wall and outer string of a flight should be set out in pairs, that is, the material is laid out with the faces uppermost and the bottom edges together.

The details in Plate XXIX may now be used for reference, the short length of string (Fig. 4) showing the method of

setting out, the construction of the steps, and the joint between string and newel. A nosing line is first drawn parallel to the top edge of the string and at a distance to produce a suitable margin. The lines of the top edges of the treads and the faces of the risers can now be marked out by using the margin templet and pitchboard as shown in Fig. 4. These lines should be cut in with a marking knife.

The pitchboard is made from a piece of thin board or plywood, in the form of a right-angle triangle, and should be very accurately cut to the size of the rise and tread, otherwise an inaccuracy will be multiplied as the templets are moved from step to step along the length of the string. As a precaution, the exact distance from point to point of each step should first be stepped off along the nosing line and these marks used as a guide when moving the pitchboard. Next mark off the width of the housings, using the tread and riser templets as shown in Fig. 3, which are shaped to include room for wedging. These lines may be drawn in pencil, and they should be drawn through to the bottom edge of the string as shown. If the work is done on a machine, and a constant shape for the nosing and scotia moulding can be maintained, then the tread templet may be made to include the shape of the nosing and scotia and the whole of the details marked out each time. With handwork there is a tendency for a slight variation in the shape of the nosings which call for the individual scribing of each nosing in the position which it will finally occupy.

The joint at the newel may be determined by fixing the riser face in the centre of the newel face and measuring back half the width of the newel. A line drawn parallel to the riser line will give the vertical shoulder line.

One method of forming the step housings is to bore three holes $\frac{1}{2}$ in. deep at the nosing end of each tread housing. This portion is then cut out cleanly to the lines with chisel and gouge and cleaned out, thus enabling the point of the tenon saw to be operated in cutting to the remainder of the lines. The waste may then be taken out with a long paring

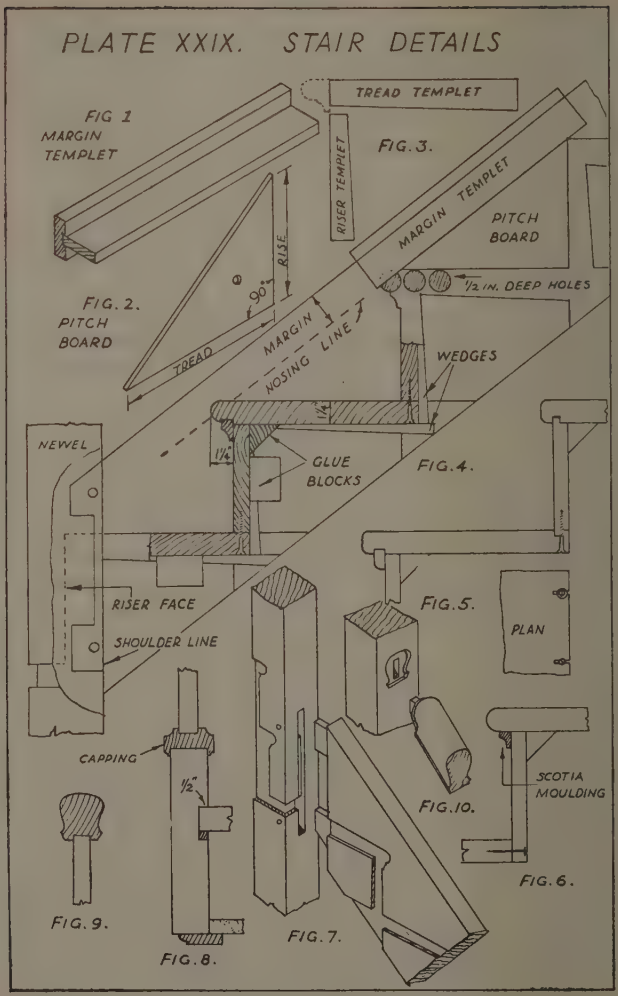


PLATE XXIX. STAIR DETAILS
FIG 1
MARGIN TEMPLET
TREAD TEMPLET
RISER TEMPLET
FIG. 3.
MARGIN TEMPLET
PITCH BOARD
RISE
90°
FIG. 2.
PITCH BOARD
TREAD
MARGIN
NOSING LINE
1/2 IN. DEEP HOLES
WEDGES
NEWEL
1¼
GLUE BLOCKS
FIG. 4.
RISER FACE
SHOULDER LINE
FIG. 5.
PLAN
CAPPING
½"
SCOTIA MOULDING
FIG. 10.
FIG. 6.
FIG. 9.
FIG. 8.
FIG. 7.

chisel and the housings continued to a fixed depth of $\frac{1}{2}$ in. with a router.

The newels are housed to receive the ends of steps according to their position in the stair. An example of this housing is shown in Fig. 7, in which case the newel is prepared to receive the ends of the winders. After the mortise and tenoning has been completed a $\frac{1}{2}$-in. dowel hole is bored into each mortise, but not completely through the post, so that it will not disfigure the outside face. The joint is then assembled and the centre of each hole marked on the tenons with the point of the twist bit. A hole is then bored in each tenon with its centre $\frac{1}{8}$ in. nearer to the shoulder line than the centre of the hole in the newel. When the joint is finally glued and assembled, the holes will not be quite in line; but when a pointed dowel is driven into the hole, it will tend to draw the newel tight up to the string. This process is known as " draw boring " and is a very useful procedure in drawing up a joint when cramps cannot be used. When assembling a flight of steps, one string is laid on the bench, and the steps, which should already have been assembled (riser, scotia and tread), are then placed in the housings in a vertical position with the other string on top.

Some form of propping from above should be arranged, as for instance from a beam or girder running in the direction of the length of the flight. This will hold the steps and strings in position while the process of wedging, glue blocking, and screwing, etc., is carried out.

The wedges used should be slender in shape, and about $\frac{1}{8}$ in.–$\frac{1}{2}$ in. in size. Several glue blocks should be used underneath the steps as indicated in Fig. 4. Various methods of jointing steps are shown in Plate XXIX, the method shown in Fig. 4 being considered the best. When screws are used for fastening the tread to the riser, slots should be formed in the material as shown in Fig. 5, so as to enable the tread to shrink without splitting the material. The method shown in Fig. 6 is not considered to be a good one, and is only used in poor-class work.

Fig. 7 shows the mortise and tenon joint between the upper end of a close-string and a landing newel. The housings for the ends of steps are also shown.

Fig. 8 is a section through a string and portion of a tread, and shows a capping moulding grooved to receive the balustrade. The top edge of the balustrade is shown in the grooved handrail (Fig. 9). Fig. 10 shows the end of a handrail tenoned into the newel.

CHAPTER X

IRONMONGERY

Hinges (Plate XXX)

THERE are many different types of hinges, and although many are adaptable, a few are used for one specific purpose only. There is not sufficient space in this book to discuss all types, but a few of the more commonly used are shown in Plate XXX. This also applies to the locks and sundry fittings shown in the other plates, but those fittings which the joiner is likely to come across in everyday use have been portrayed for reference.

The hinges shown in Figs. 1 and 2, although differing slightly in construction, may be used for the same purpose, that is, the hanging of ledged and battened doors.

The strap portion is secured with screws on to the face of the door or on the ledge of the door and the plate or flap fixed on the edge of the door frame, with the centre of the knuckle opposite the joint.

The band-and-gudgeon type (Fig. 3) may be obtained in sizes up to 3 ft. long, and is used for a heavier class of work, such as large-framed ledged and braced doors and heavy gates. The gudgeon or pin shown in Fig. 3 is mounted on a plate, which is let into the face of a wooden frame or post and screwed on. This fixing is suitable for light work only, and should be replaced by a stronger form of hinge if it is intended to carry a heavy overhanging weight.

The gudgeon at *A* would be used in the top position when hanging a heavy gate to a wooden post, as the nut and washer would prevent it from being withdrawn. The bottom gudgeon need not go through the post, but it should have a spiked end to enable it to be driven part-way into the post. The pin will not come out, as there will always be a tendency for the pressure of the gate to push it into the post. The gudgeon at *C* is the type usually built into brickwork,

and the one at *B* is for use with stone posts. The gudgeon is inserted into a hole in the post and the hole filled with molten lead, the dovetail shape and the ragged edges preventing it from being withdrawn.

Butt Hinges (Fig. 4) are used mostly for hanging doors where the flaps are let into the edge of the door and the framing surrounding the door and are held by screws.

Butt hinges are made of cast iron, wrought iron, pressed steel, and brass, and may be obtained in a variety of sizes, from the tiny brass hinge for small boxes and cabinets to the large cast-iron butt hinge which may be up to 6 in. long.

The Projecting Butt Hinge is used where a door is required to open back against a wall and clear some obstruction, such as an architrave moulding or plinth block.

The Rising Butt Hinge has a specially shaped helical joint which causes the door to rise on being opened. It is particularly useful when a door is required to clear a carpet or an uneven floor.

Back Flaps (Fig. 7) are used for face fixing on thin doors and shutters where it is not suitable for the edge fixing of butt hinges. Type *B*, which has one flap longer than the other, is used on such joints as the rule joint in a table leaf.

The Parliament Hinge (Fig. 8) is similar to the projecting butt hinge, and is used on doors and shutters in recesses when they are required to open out and fold back clear of the recess.

The Strap Hinge shown at *A*, Fig. 10, is the type used for hinging two shutters together, the long straps giving greater fixing strength than the ordinary back-flap hinge. The cranked strap hinge is suitable for a box lid (see sketch at *C*), or any such position where edge fixing would not give sufficient strength.

The Counter-flap Hinge (Fig. 9) belongs to the same category as the link-plate hinge (Fig. 11). Instead of the usual knuckle with a single pin through it, these hinges have two pins.

PLATE XXX. HINGES

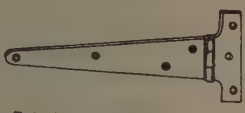


FIG. 1. CROSS GARNET

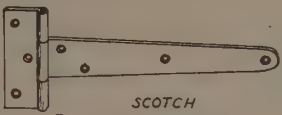


FIG. 2. SCOTCH TEE HINGE

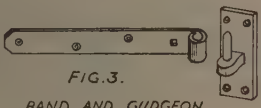
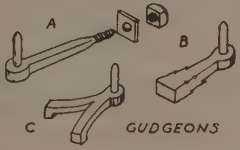


FIG. 3.
BAND AND GUDGEON



GUDGEONS

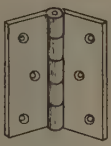


FIG. 4.
BUTT HINGE

FIG. 5.
PROJECTING BUTT

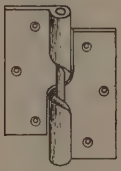


FIG. 6.
SKEW OR RISING BUTT

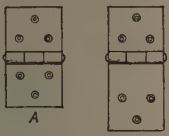


FIG. 7.
BACK FLAPS

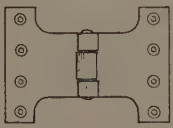


FIG. 8.
PARLIAMENT HINGE

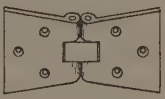


FIG. 9.
COUNTER FLAP

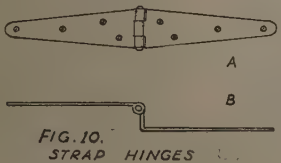


FIG. 10.
STRAP HINGES

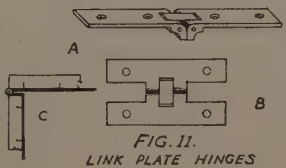


FIG. 11.
LINK PLATE HINGES

In order that the hinge will operate, the pins are connected by a tumbler or link piece, which is flush with the upper surface of the hinge. The hinge is let in with this surface flush with the wood and nothing is left protruding. The counter-flap hinge, as its name implies, is used on counters where a portion of the counter top is required to fold back and lie on the remainder. When closed down there should be no knuckles on the hinges to project.

Two other types of hinges are shown in Fig. 11. The type shown at *A* is for use on narrow edges and that at *B* is for use where there is more room or where greater fixing strength is required. These hinges are used on desk flaps and folding tables or any similar work.

Locks (Plate XXXI)

Under this heading should be included latches, bolts, etc., as they, with all types of lock, are termed door fastenings. The particular type of fastening to be used is dependent on the situation and to a great extent the class or quality of the work.

For instance, the ordinary battened door usually requires some convenient form of catch, such as the thumb latch shown in Fig. 1, or it may have the addition of a bolt, such as the tower bolt (Fig. 12). The bolt is a form of lock which can only be operated from one side of a door, and therefore would be unsuitable where a door is required to be locked from both sides.

The Dead Lock (Fig. 4) is a box or case containing a sliding bolt which is held in position by spring-loaded levers, and can only be operated by turning a key, which action will release the levers and slide the bolt in or out.

Cheap locks have perhaps one lever of simple design, and may be opened quite easily with a variety of keys, but the more expensive locks have a number of carefully arranged levers, and require a specially cut key to operate them, thus rendering the lock more difficult to open with any but the right key.

PLATE XXXI. LOCKS

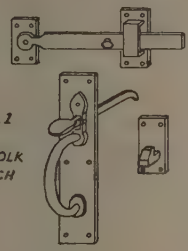


FIG. 1
SUFFOLK LATCH

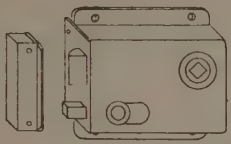


FIG. 2. RIM LATCH

FIG. 13
KEYHOLE ESCUTCHEON

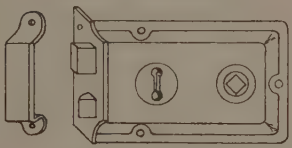


FIG. 3. RIM LOCK

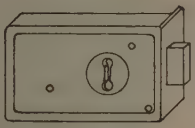


FIG. 4. DEAD LOCK

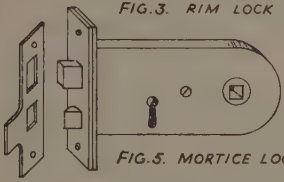


FIG. 5. MORTICE LOCK

FIG. 7.
SLIDING DOOR LOCK

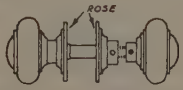


FIG. 6. DOOR FURNITURE

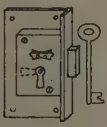


FIG. 8.
CUT CUPBOARD LOCK

FIG. 11. BARREL BOLT

FIG. 10.
FLUSH BOLT

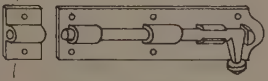


FIG. 12. TOWER BOLT

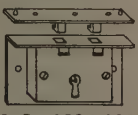


FIG. 9. DESK LOCK

The Rim Latch (Fig. 2) is the type used on the inside of bathroom and lavatory doors or in similar positions where the door is not required to be locked from both sides. The spring-loaded catch is operated by turning a knob, and the small finger catch may be used to lock the door from the inside.

The Rim Lock (Fig. 3) is a combination of both dead lock and rim latch, and is used for the ordinary class of work where appearance does not greatly matter. These three types of lock are screwed on to the face of the door with the small flange let into the edge of the door.

The Mortise Lock (Fig. 5) is used on good-class work where a rim lock would be unsightly. A mortise is made in the edge of the door to take the case, and the end plate is let into the edge of the door and secured by screws. With the mortise lock a flat striking plate is let into the rebate of the door frame, as different from the box or keeper, which is fixed to the edge of the frame for the rim locks, etc.

The Door Furniture (Fig. 6) consists of a spindle, knobs, and rose plates. Owing to the varying thicknesses of the doors, the knobs are made adjustable, and may be secured in the desired position by a small grubscrew. The rose plates are fixed to the door to prevent the knobs and spindle from enlarging the hole, and for the same reason a keyhole escutcheon (Fig. 13) should be used for all keyholes. Where a mortise lock is used, a rose plate would be required on each side of the door, but with a rim lock or latch, only one plate is needed. The small brass locks shown in Figs. 7, 8, and 9 are designed for the purpose which their name implies.

The Cupboard Lock may be obtained with the keyholes cut as indicated, which would enable it to be used as a drawer lock also.

The Flush Bolt (Fig. 10) is a neat form of bolt which is fitted to the edge of one of a pair of doors, when there is not sufficient room to fix bolts on the inside of the door.

Sundry Fittings (Plate XXXII)

The fittings shown in Plate XXXII have been selected as some of the more important from the large collection of sundry fittings with which the joiner comes in contact.

The Sash Fastener (Fig. 1) is one of the many different patterns of fastener for use on the meeting rails of a double-hung sash window. The lever is spring loaded, and may be retained in the open or closed position. Its action against the wedge-shaped nib tends to draw the two sashes together and prevent them rattling, also from being opened.

Two Sash Handles, such as in Fig. 2, should be screwed to the underside of the meeting rail to the top sash and used when pulling down the sash.

Two types of sash lift are shown in Figs. 3 and 4 ; these are for fixing to the inside face of the bottom rail, and afford a finger grip when raising or lowering the sash. The flush type is neater and more effective than the hook-sash lift.

The Casement Stay (Fig. 5) may be obtained in many different designs, and in lengths of 10, 12, or 15 in. It is fastened to the bottom rail of a casement sash, with the pin plate fixed to the top of the sill, and its main purpose is to secure the sash in the desired open position. The sash is locked in the closed position by means of the casement fastener, two examples of which are shown in Fig. 6. The fitting shown at *A* is known as a " cockspur " fastener, and has a mortised plate for the spur portion to fit into. The handle is fixed to the closing stile of the sash and the plate to the frame. The plate in *B* has a wedge-shaped nib cast on, its purpose being to assist the handle in drawing the sash tight into the rebate.

Quadrant stays (Fig. 7) are used in pairs for fanlights which open inwards. They are fixed to the rebate of the frame, and support the sash in its maximum open position. The roller stay (Fig. 8) is used for the same purpose, but with this the sash is allowed to open gently by falling against the stay, the roller of which is always in contact with the sash.

PLATE XXXII. SUNDRY FITTINGS

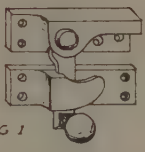


FIG 1
SASH FASTENER

FIG. 2. SASH HANDLE

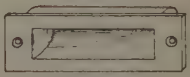


FIG. 3.
FLUSH SASH LIFT

FIG 4.
HOOK SASH LIFT

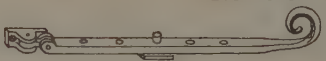


FIG. 5. CASEMENT STAY

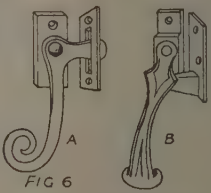


FIG 6
CASEMENT FASTENERS

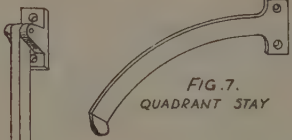


FIG. 7.
QUADRANT STAY

FIG. 8.
ROLLER STAY

FIG. 9.
CLEAT HOOK

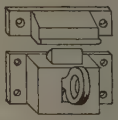


FIG. 10
FANLIGHT CATCH

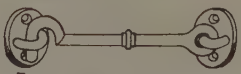


FIG. 11. CABIN HOOK

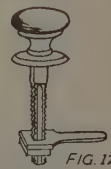


FIG. 12.
CUPBOARD TURN

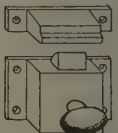


FIG 13 SPRING
CUPBOARD CATCH

FIG. 14. FLUSH
DRAWER HANDLE

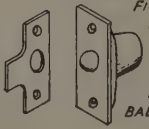


FIG. 15.
BALL CATCH

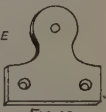


FIG. 16.
GLASS PLATE

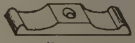


FIG. 17.
TURN BUTTON

These may be used to advantage where a fanlight is out of reach and the sash cannot be lowered gently by hand against the stops as should be done when the quadrant stay is fitted.

Fig. 10 shows a Spring Fanlight Catch, such as would be fitted to the top rail of the pivot hung sash (Plate XXIII). It is operated by pulling down on the eyelet either with a hook pole or by a cord which is fastened to a cleat hook (Fig. 9), that in turn is screwed against the wall.

The Spring Cupboard Catch (Fig. 13) is of similar construction, but usually it is not as strong as the one shown in Fig. 10. It is fixed to the face of the cupboard door and operated by turning the knob. A cheap and simple form of cupboard fastening is shown in Fig. 12, but it is not recommended, as constant turning of the spindle very soon enlarges the hole in the door. The Turn Button (Fig. 17) is a very simple form of fastening, and the Ball Catch (Fig. 15) will keep a door closed and allow it to be opened and closed when desired without operating any levers or knobs. Gates and doors, especially garage doors which need to be kept open in a wind, may easily be secured with the Cabin Hook (Fig. 11.)

The Glass or Mirror Plate (Fig. 16) is screwed to the back of such articles as mirrors, shelves, or wall cabinets. The round portion is left projecting, and carries the screw which is fixed into the plug. One form of drawer pull is shown in Fig. 14; the swivel handle falls back into the finger recess, and gives a clean appearance to the drawer front.

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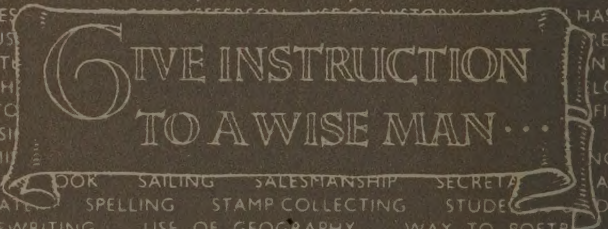

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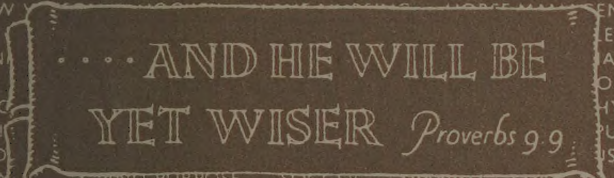

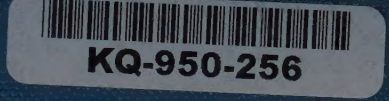
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